The Dock and Harbour Authority

No. 303. Vol. XXVI. Edited by BRYSSON CUNNINGHAM, D.Sc. B.E., F.R.S.E., M.Inst.C.E. JANUARY, 1946

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Editorial Comments

New Year

We initiate the first issue of this Journal in the New Year with a cordial greeting to all our readers in every part of the world. May 1946 prove for them in every respect "A Happy New Year."

It is to be regretted that this wish, though heartfelt, cannot be uttered with complete confidence. It is an act of faith, perhaps rather of hope, for it has to be admitted, unfortunately, that circumstances at the present time are fraught with uncertainty, and even with anxiety. The world is still in a troubled state, and in this country the issues of the general election have yet to be faced. Port Authorities, indeed, are perplexed. They feel themselves in the hands of a Government bent on trying large scale experiments in nationalisation, not in a cautious and statesmanlike way, but, from the evidence of pronouncements in Parliament, in a spirit of rashness more characteristic of Micawberism than of British common sense. At any moment port commissions and directorates in this country may be "liquidated"—discarded as effete and out-worn anachronisms.

Yet there is a ray of hope. "There's many a slip 'twixt cup and lip," says the proverb, and, however confidently the sentence of excommunication may have been pronounced on private enterprise, it has not yet been carried into effect. There are many that hope that it never will.

Proposed New Port Authority for the Clyde

The Report issued in the early days of the past month by the Clyde Estuary Committee is a document of outstanding interest and importance in port circles. Within the limits of editorial comment in a single issue of this Journal, it would be impossible to do justice to the wide range of topics in its exhaustive purview, and to deal in any adequate degree with the full extent of its recommendations. On a later page our readers will find set out the more salient observations and conclusions, principally as regards the constitution of the proposed new port authority for the Clyde area, leaving certain subsidiary recommendations on suggested improvements and additional facilities for notice at a later date.

Looking at the Report as a whole, we feel we must pay a tribute of praise to the manifest and painstaking care which has gone to its preparation. Lord Cooper and his colleagues, Sir Robert Letch and Mr. Robert Taylor, are to be warmly complimented on the production of an exemplary document. We do not propose to scrutinise all their findings in detail; indeed, without extensive research and access to the wealth of information collected by the Committee, it would be futile to attempt anything of the kind. We must confine our observations to a few salient points, and these will be found in no sense adverse to the general conclusions of the Report.

The main finding is the necessity for a unification under a single authority of the present unduly numerous administrative bodies on the banks of the Clyde, a step not necessarily advantageous for adoption under all circumstances, even where they appear to be similar, but justified in this case by the evidence adduced. The Clyde Estuary ports are a congeries of ports of varying size and importance, among which Glasgow ranks first and foremost. It is, in fact, the sun of the Clyde port planetary system, which includes some very minor satellites. The reputation of the Clyde Navigation Trust, the port authority of Glasgow, stands deservedly high and compares favourably with that of any other port administration in the country. But several of the other organisations are not so happily placed and a few are, or have been, actually in financial difficulties or straitened circumstances, with the inefficiency of operation which such a handicap entails. The remedy for this state of affairs is, undoubtedly, amalgamation of duties and operation.

In framing their scheme of administration, the Clyde Committee have had a close eye on the example of the Port of London, where various independent and competing dock companies have been successfully combined in a single organisation, to the undoubted advantage of the trading community and the shipowners. The one prominent feature in which the Port of London Act has not been followed is in regard to the lighting and buoying of the river channel, which, in the case of the Thames, remains (as with a number of other rivers and estuaries) in the hands of Trinity House. On the Clyde, it is proposed to abolish the Clyde Lighthouses Trust and to incorporate its functions with those of the proposed Port Authority. The Report states that no reasonable justification can be found for maintaining the Lighthouses Trust as a separate entity. This may well be conceded, but it is open to question whether the administrative functions of that body should not be transferred to the Commission of Northern

Editorial Comments—continued

Lights, which occupies in Scotland pretty much the same position as does Trinity House south of the Tweed. Dredging operations should undoubtedly be the responsibility of the Port Authority. They have nothing to do with Channel demarcation. They belong to the domain of river conservancy.

The next, and perhaps the most essential, consideration after the acceptance of the principle of amalgamation under a single authority, is the composition of this authority. The Report recommends the formation of a body of 21 members, exactly a moiety of the actual constitution of the Clyde Navigation Trust, which we have always regarded as excessively high. Indeed, it is the largest body of its kind with which we are acquainted, though the River Tyne Commission with 36 members and the Humber Conservancy with 37 run it fairly closely.

It is laid down in the Book of Proverbs in Holy Writ (Prov. xi., 14) that " in the multitude of counsellors, there is safety." This may be so, but there is also scope for wide diversity of opinion—" *Quot homines, tot sententiae* "—a tendency to verbosity and a possibility of utterances of doubtful value and wisdom. We feel that large consultative assemblies are, generally speaking, unwieldy and cumbersome and that the most effective work is done by small, compact bodies, such as committees. The proposed limitation of the Clyde Trust to 21 members should, therefore, command approval. Membership should not be so low as to leave an insufficient margin for occasional unavoidable absenteeism, and in this connection it would be interesting to see the analysis of the attendance registers of the 14 leading port authorities made by the Committee.

As regards personnel, it is to be noted that the 21 members specified include five municipal representatives out of nine nominees, as against 12 members elected by trading and shipping interests. We are inclined to look askance at so high a proportion of municipal nominees, since purely civic affairs are not of the first order of importance in port administration. Indeed, the Committee themselves go so far as to state that (with two exceptions) they see no grounds for conceding representatives to local authorities, *as such*. Labour has a special representative, but we fear that his sole pre-occupation will be to secure advantageous wage conditions for port employees and that he may neglect the wider interests which are essential to commercial prosperity.

We have already stated that the topics in the Report for discussion are too numerous and complex for compression within a single Editorial Comment. If the reception of the Report by the Government warrants its further consideration (a moot point in view of their nationalisation programme), we will return to the subject in a later issue.

Tees-side Development

Following mature consideration of the many complex interests involved, the Tees Conservancy Commissioners have approached Parliament for the powers necessary to enable them to carry out a bold scheme of port and river development. They envisage a future bright with local commercial enterprise and industrial activity, which will bring Middlesbrough into the ranks of the leading ports of the country and make it not only a thriving manufacturing centre but also a valuable contributor to the country's export trade.

As a natural and almost inevitable preliminary to a vigorous policy of this kind, the Commissioners, in their Bill which is summarised elsewhere in this issue, have put forward a scheme for the unification of the unduly numerous reparian authorities at present in existence, and they propose the creation of a Trust of more widely extended interests so that in place of 21 members, as at present, there shall be 28 members, including 13 representatives of local urban and suburban councils.

It will at once be apparent that this step is in a contrary direction to that taken in the Clydeside proposals, in which the port authority membership is to be reduced from 42 to 21. Moreover, in the Clyde Estuary Committee's Report, the representation of local authorities, *as such*, is deprecated, a view in which we fully concur, for as we have said in that connection, civic and urban matters are of subordinate importance in port affairs and do not call for direct representation. It may be objected that provision is made in the Bill for the issue of loans to the Commission by the Middlesbrough, Stockton and other local Councils, but in our view this does not affect the position. Such loans are merely investments and the standing of the lender Councils is the same as that of the private investor. The Councils would presumably not be payers of rates to the Commission and the converse of the principle, " No taxation without representation," is equally sound, viz., no direct representation apart from actual financial liability.

It may, however, be futile to continue discussion on such private bills until the Government have clarified their attitude towards port nationalisation. We shall, therefore, withhold further comment for the moment.

Sheet-Piling.

Sheet-piling as a means of sustaining embankments of earthwork, so as to provide them with a more or less vertical face, is a common feature of engineering construction, and it has particular advantages as applied to quays and wharves of moderate height. The Discussion on the subject at a recent meeting of the Maritime and Waterways Engineering Division of the Institution of Civil Engineers, was therefore timely and likely to be helpful to designers of such works. In his Introductory note (which with the ensuing discussion is reproduced in this issue) Mr. Savile Packshaw briefly surveyed the several types of sheet-piling in common use, commencing with a statement of the relative merits of the materials employed, viz.: timber, reinforced concrete and steel. Despite the fact that the first-named has not yet outlived its popularity in the past, and that reinforced concrete has convinced adherents, the general consensus of opinion among present-day engineers will, we think, incline towards the employment of steel sheeting piles on account of their convenience and adaptability and the more effective interlock they provide.

The one doubtful consideration, as pointed out by Mr. Packshaw, is the question of durability, especially in maritime situations, where the salinity of the water exercises a strong deteriorating action. There are certainly ingredients, such as copper, a small percentage of which can be introduced into the metal as a means of preventing, or at any rate, retarding corrosion, but records are not yet of sufficiently long standing to justify absolute confidence in such expedients. Nickel steel and chromium, though undoubtedly effective for the purpose in view, are too expensive for general adoption. When we have had occasion to use steel sheet-piling and the circumstances permitted, we have always added a coating of pitch or tar over the surface of the piles, to supplement the protection afforded by the copper content in the steel. This coating is, of course, liable to be damaged or removed by abrasion, especially in the case of wharf frontages, but it serves, at any rate, as an additional precaution which may remain unimpaired for a considerable time. Moreover, it can be renewed as occasion requires.

The Discussion at the meeting, it will be noted, followed along the lines of design rather than of durability, and it is for this reason that we have raised the latter question in the foregoing comment. It is one of many aspects of the matter all deserving of consideration, and we think that the Discussion has served a very useful purpose in focussing attention on the subject of sheet-piling generally.

Dock Labour Regulation

The Bill to regularise labour employment at British docks —" Dock Workers (Regulation of Employment) Bill "—has been passed. In the course of the debate in the House of Commons on December 10th, categorical allegations of wasteful and redundant labour and inefficiency in dock working were made by Mr. Peter Thorneycroft and challenged by Labour members. At the close of the discussion, the Minister of Labour announced the formation of a special committee to examine the position, viz.: A joint committee of the National Joint Council, with the following terms of reference: " To examine the industrial arrangements of the industry on the basis that there shall be permanent schemes of decasualisation and to report." An independent chairman was to be appointed by the Ministry of Labour.

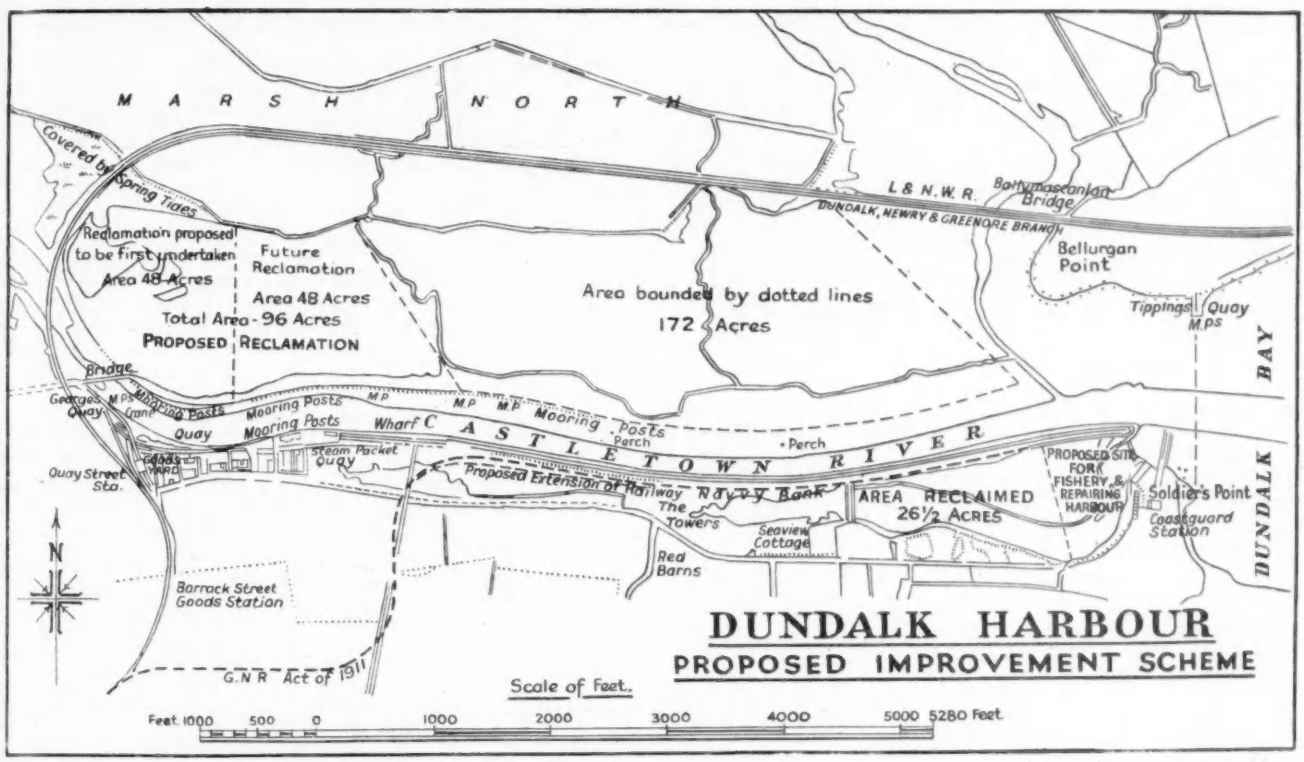
The Port of Dundalk

A West of Ireland Seaport

By AL. KANE.

Ancient History

DUNDALK, seaport and capital town of Louth, the smallest county in Ireland, has a history dating back to the second century. B.C. Its ancient Gaelic name, Traig Baile MacBuain, commemorates the romance of Baile MacBuain, son of the King of Ulster, and Aillinn, the beautiful grand-daughter of the King of Leinster.



During the era of the Red Branch Knights, Dundalk basked in the reflected glory of Emania, the Royal Residence of the Kings of Ulster, while it also claims to have been the birthplace of Chuchullen, the hero of ancient Irish history and legend.

The fine natural harbour of Dundalk attracted the attention of the Danes early in the 9th century, and it is recorded that in 839 a formidable Danish fleet dropped anchor in the bay and landing in considerable force, marched inland, pillaging and laying waste the countryside around them. On arriving at Armagh, they attacked that city and burned it to the ground.

Later Annals

The harbour of Dundalk is formed by the Castletown River, which flows from the northern end of the town into the Bay, and the earliest existing chart of the Bay is Mackenzie's Admiralty Chart of 1776.

The first record of any attempt to improve the natural harbour at Dundalk is found in 1746, when Lord Limerick had the harbour cleaned. In the same century the construction of a quay is recorded. It was situated a little less than half a mile from the town and was capable of accommodating vessels up to 130 tons.

In 1767 the Irish Parliament voted a sum of £2,000, and a further grant of £400 yearly for a period of eight years, for work on the harbour. The monies thus voted were entrusted to Lord Limerick, who, however, instead of spending them as they were originally intended to be spent, appropriated them for his own private use. However, it appears that he had never received any payment for the work he had earlier carried out at the harbour, and he may have regarded the later grants as belated recompense. During the 18th century in Ireland such manipulation of funds voted for public works was not altogether unusual. Further, until the passing of the Act which constituted the Harbour Commissioners, the care of the harbour was regarded as being the concern of the quay owners, shipowners and the Lord of the Soil, Lord Roden.

By the early 19th century, Dundalk had developed a considerable export trade in flour, meal, malt, butter, beef, pork, cattle, sheep, pigs, linen, flax, eggs and poultry. In 1835 the value of Dundalk's exports amounted to £452,813, while imports from Great Britain were valued at £107,053, and included coal, bark, soap, oil, tallow, hemp, rock salt, tea, sugar and iron. From foreign countries the imports were tallow, hemp and flax from St. Petersburgh and Riga; timber and iron from Danzig, Memel, Stockholm and Gottenburgh; bark, flax and clover seeds from Rotterdam; barilla, cane reeds and wine from Alicant; wine from Oporto; and timber from the British Americas.

The principal Dundalk merchant engaged in this foreign trade during the first half of the last century was Mr. James Kieran, whose brother, Mr. William Kieran, was the proprietor of an extensive beef and pork curing factory, and who, for a number

Photographs and map by courtesy of the Dundalk Harbour Commissioners.

Port of Dundalk—continued

of years, had held a Government contract to supply the British Navy with provisions.

In later years Dundalk's overseas trade was taken over by a number of firms, prominent among them being those of Messrs. William J. Hogg; Martins & Fitzpatrick; Anthony Marmion; John Chambers & Co.; and John Robinson.

First Harbour Commission

The growth of Dundalk's commerce soon rendered an improvement of the port facilities imperative, and in 1837 the Acts 3rd and 4th Vic., C. 119, for " regulating, preserving and improving the port and harbour of Dundalk " were passed.

Under these Acts, which constituted the first Harbour Commissioners, comprising 27 members, powers were given to the Commissioners to borrow up to £120,000 for the purpose of deepening and scouring the river, and also for the erection of the tidal bank, now known as the Navy Bank, which extends from the south bank of the river to Soldier's Point. The reclamation of the strand area inside the inner harbour was also visualised in these Acts.

Following the passing of these Acts, plans were drawn up by Sir John MacNeill, in which he advocated changing the course of the river from the south to the north channel, and also the carrying out of extensive dredging operations.

During the next few years the Dundalk Steam Packet Company, founded by Mr. Neal Kelly, built extensive warehouses at Dundalk, and spent a considerable sum of money in improving their quayage. MacNeill's plan was adopted by the Harbour Commissioners, and a solid embankment, extending from Soldier's Point to the Steam Packet Company's quay, a distance of 1¼ miles, was built at a cost of £10,000. A 17 h.p. dredger was purchased and the river straightened and the depth of the channel, from Soldier's Point to the Bar, increased until it was possible for vessels with a draft of 16-ft. to come up to the quay. Several weirs were also removed, and the whole river well lighted and buoyed and fitted with mooring posts. In 1853 a lighthouse, 45-ft. high, was erected just inside the Bar. The work, carried out under Sir John MacNeill's plan, cost the Commissioners a total of £20,150.

Considerable work of improvement was also carried out at the port by Mr. P. Russell, a prominent Dundalk citizen. He took over the old Custom House Quay and extended it as far as Martin's Quay. He also filled in a very objectionable mud-bank, along which he erected extensive wharfage. These improvements greatly increased the trade at the port, and during the twelve years from 1841 until 1853 the gross annual revenue of the port increased from £1,672 to £3,369, although it was not until 1848 that goods landed there became subject to dues. The fishing industry of the district also made satisfactory progress, and by 1851 there were 283 fishing boats registered there, the total number of men employed on them being 1,365.

In October, 1845, an enquiry was held at Dundalk by the Tidal Harbour Commissioners, at which some interesting information regarding the development of the port was disclosed.

The Clerk of the Dundalk Harbour Commissioners, Mr. Byrne, said that the average income at the port was £1,800 p.a. In 1844, 716 vessels, with a total tonnage of 80,000 tons, had called there. The outstanding debts amounted to £16,650. The Parliamentary Survey, upon which the 1837 Act had been based, had cost £650.

The improvements made at the port were then detailed by the resident engineer, Mr. Richard Needham, who said that parts of the channel had been deepened 5 to 8-ft. Forty acres of strand area had been cut off by the embankment. The depth of water over this averaged 6-ft. at H.W.S.T. The rise of the tide was 16-ft. at the bar and 7-ft. at the bridge.

When they had the work completed the channel would be 150-ft. wide at the quays and 300-ft. wide at the Point. The cost of dredging had been 8d. per cubic yard. He had lifted the stuff 4-ft. at the bar. The foundations were hard.

Sir John MacNeill, who also gave evidence at the enquiry, confirmed what had been said by the resident engineer, and explained the great scope for improvement which still existed.

Constitution of Harbour Trust

In 1855 the Harbour Trust was constituted by special Act of Parliament, of which the following were the principal clauses:—

(1) To extend the limits of the Port and Harbour seaward to a line drawn from the extremity of Dunany Point on the south, to Cooley Point, on the north side, to bring the whole of Dundalk Bay within the jurisdiction of the Commissioners.

(2) To authorise the Commissioners to deepen, cleanse, scour, dredge, improve, manage and maintain the Port and Harbour within these limits.

(3) Among the works contemplated in the Act were the reclamation and embanking of land within the entrance to the Inner Harbour at Soldier's Point, and the straightening of the channel thence to Dundalk.

(4) To run out to sea, from the mouth of the Inner Harbour, two guide walls or embankments, 3 miles long, across the foreshore; to fix the channel and reclaim the lands occupying the angular space formed by the said embankments and the adjacent coastlines.

The reclamation of the strand area was one of the principal objects of this Act, and the administration, in its report to Parliament, stated that it was hoped to reclaim an area of 4,648 acres, of which 710 were inside Soldier's Point.

The Admiralty, however, considered that the suggested reclamation within the harbour would reduce the volume of water entering the harbour from between 8 and 9 million cubic yards to 7 million cubic yards, to the consequent deterioration of the port. Accordingly the Admiralty refused permission for any further reclamation of the tidal space within Soldier's Point. No objections, however, were offered to reclamation work within the angular space of foreshore outside Soldier's Point.

Soon after the Crown acquired, under Section 63 of the Harbour Act, the ownership of any lands reclaimed outside the Inner Harbour. The Constitution of the Harbour Commissioners was also altered, and their numbers reduced. The reconstituted Commissioners were given borrowing powers to the amount of £49,000, in addition to any sums borrowed under the Act of 1837, thus giving them power to borrow up to practically £70,000 on the credit of the Port.

Admiralty Survey

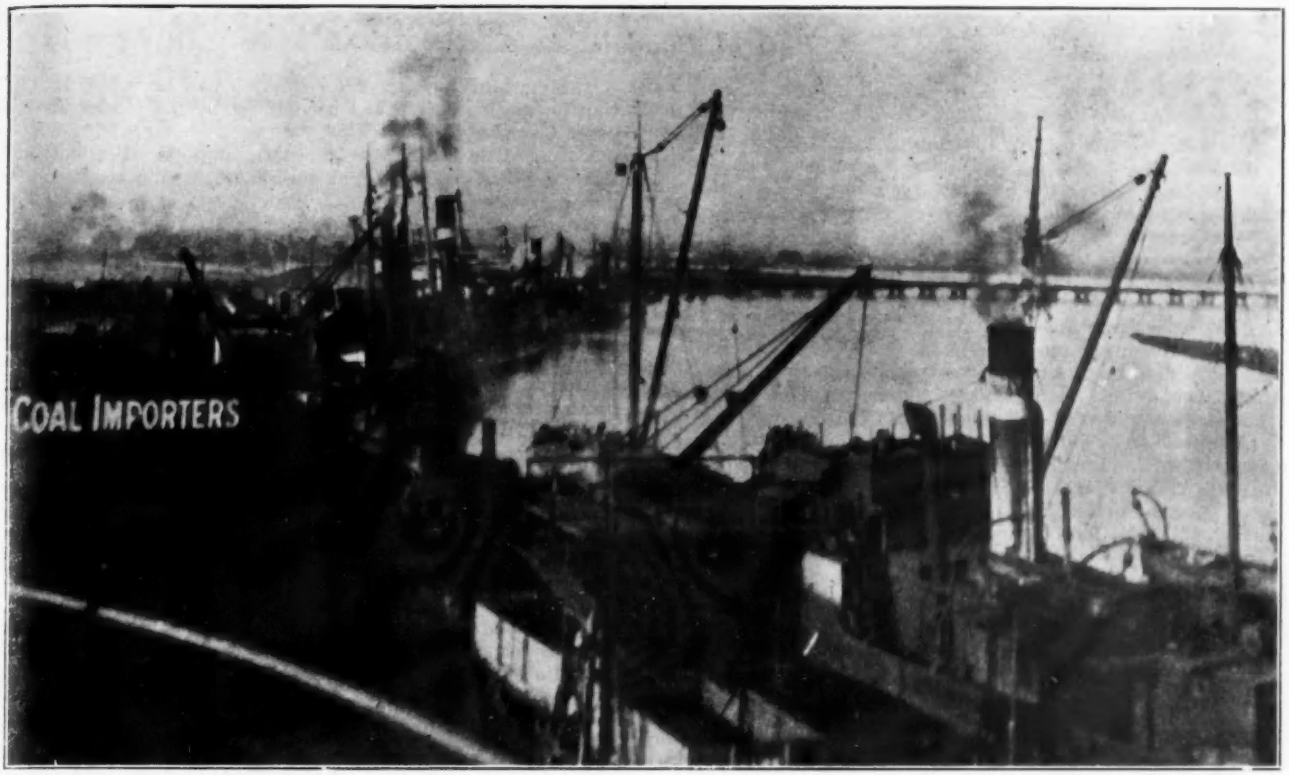
In 1858, an Admiralty survey was made of the Port and Harbour of Dundalk by Captain Hoskyn, R.N.

This survey showed a bar near the lighthouse with from 2 to 3-ft. at L.W. Westwards of the lighthouse was a bar-hole 7 to 8-ft., and near Shell Island another hole with 19-ft. at L.W.

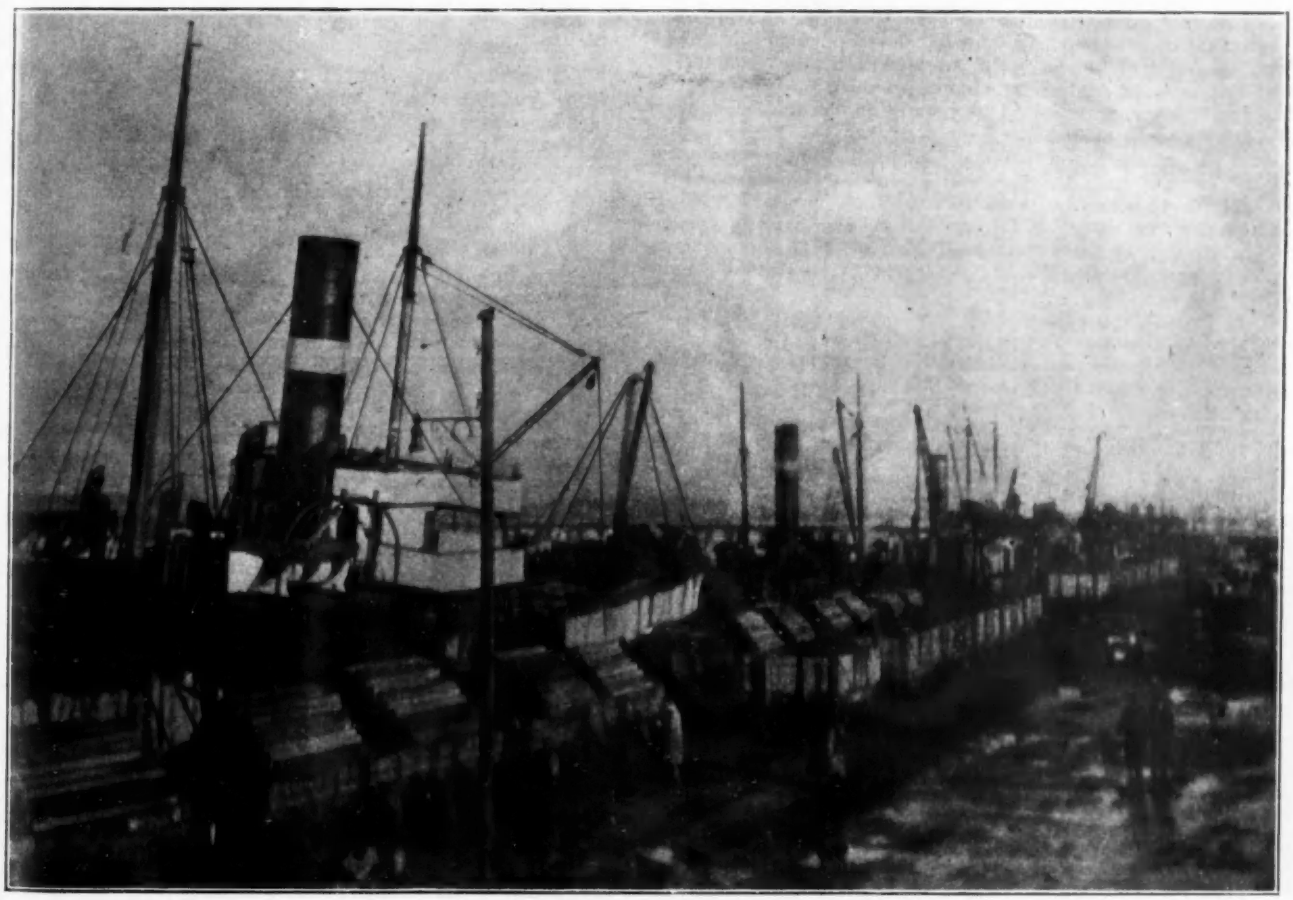
Shortly after, the Harbour Commissioners requested Mr. Telford MacNeill to submit a scheme for the improvement of the port, and in 1861 they asked Sir John Rennie to report upon Mr. MacNeill's plan. The result of Rennie's consideration was received in June, 1862, and was an endorsement of Mr. MacNeill's plan, which Rennie opinioned would be very beneficial to the port if properly carried out.

Captain Hoskins, however, reporting for the Admiralty, whose permission was necessary before the work could be undertaken, disapproved of the plan, and stated that in his opinion silting would take place behind the proposed embankments, thereby reducing the tidal capacity of the harbour. He also said that too much attention was being given to the Inner Harbour. He advised the removal of all impediments to the free ebb and flow of the tide, and the construction of a training wall in the Outer Harbour to guide the tidal stream into the channel, and, if possible, fix the channel over the Bar.

As a result, Mr. MacNeill's scheme was dropped, and in January, 1864, Mr. John Neville was asked to submit a report upon the condition of the port. His report was received the following March, and he suggested the construction of training walls on both sides of the Outer Harbour and the removal of certain shoals. He estimated the cost would be £43,250, made up as follows:



Coaling Berths at Dundalk



General Cargo Berths at Dundalk

Port of Dundalk—continued

Stone training walls	£12,500
New dredge and hopper barges	£12,000
Dredging from the Lighthouse to Soldier's Point	£18,750

With some slight changes, including a considerable extension of the training walls, Mr. Neville's plan received the sanction of the Board of Works in 1870.

Soon after, the construction of the training walls was begun and continued until 1881 at a cost of £17,100. Later, further work of increasing the height of the walls at the east bank was carried out.

In 1879, new dredgers were purchased and an average increase of 4-ft. in the depth of the water in the channel was obtained.

In 1895, the Commissioners requested Mr. Crosthwaite to carry out a further survey. This work, completed the following year, was most valuable to the Commissioners, as up to then it was the most accurate yet made of the port. In addition, Mr. Crosthwaite also submitted a valuable report on his observations. As a result of his work, further dredging was undertaken, which resulted in considerable improvements.

In a report on the harbour made to the Commissioners in 1896, Mr. (later Sir) J. Purser-Griffith made these recommendations:

(1) That no further extension of the training walls be sanctioned.
(2) That an experimental contract be entered into for sand-pump dredging.
(3) That the Commissioners' bucket dredger be employed in straightening and widening certain portions of the channel specified in the report.
(4) That the deposit of dredged material within the harbour be forbidden.
(5) That certain defects in the lights of the harbour be rectified.

His last three recommendations were adopted by the Commissioners, but during the following ten years the training walls were extended at a cost of about £3,000. Mr. Griffith's advice about suction-dredging was not adopted until the summer of 1906, but in the meantime, by means of their bucket dredgers, the Commissioners removed an average of 58,000 tons of detritus per year, at a cost of 8½d. per ton, or £2,000 p.a.

Some idea of the sound financial position of the Commissioners may be gleaned from the fact that in 1896 they raised a loan repayable in 40 years, but actually paid it off 11 years before it matured. In 1889 there was a debit of £19,000 on the nett revenue account of the Harbour Commissioners; in 1912 there was a credit balance of £1,126. By the end of 1930, the credit balance was £15,008.

By the beginning of the present century, vessels of 16-ft. draft were able to discharge at the quays, which were provided with a number of steam cranes, and served by the Great Northern Railway and the London & North Western Railway.

Later Improvements

In 1906 the deepening of the channel from the bay to the quays to such a depth as would allow vessels engaged in the coastal trade to enter or leave on all tides was recommended. It was estimated that in order to increase the depth of the channel, so as to make the port available for shipping at all tides, 7,200.000 tons of detritus would have to be dredged, at an estimated cost of £120,000, plus £20,000 for plant and appliances.

In 1925 the new Harbour Act was passed by the Irish Government, giving the Commissioners wider powers than they had formerly held. Under this Act the Commissioners purchased a number of privately owned quays. Some years later, finding these quays unfit for the growing traffic, they decided upon their reconstruction, and borrowed a sum of £35,000 from their Bankers for the work. A further sum of £5,000 was also obtained on an overdraft, the Irish Government giving its guarantee for the payment of the interest and the repayment of the principal. These loans were negotiated under the Act of 1925, which empowered the Dundalk Harbour Commissioners to borrow up to £55.000.

On June 22nd, 1931, Dundalk's new quays were opened by President William Cosgrave, attended by Mr. McGilligan, Mr. W. Twibill, Chairman of the Harbour Commissioners, Miss M. Twibill, Mr. T. F. McGahon and Mr. C. P. Glendon.

The consulting engineer for this job had been Mr. P. H. McCarthy, and the work was carried out by the Yorkshire Hennebique Company.

During 1938 and 1939 the coal imports at Dundalk Port totalled 279,971 tons. Other miscellaneous imports for the same period totalled 52,294 tons. Exports amounted to 7,227 tons, and livestock numbered 28,695.

The berthage and wharfage available at the port totals about 2,400-ft. There are two large sheds on the quays, the property of the B. & I. Steampacket Company. Six steam locomotive cranes are available for loading and discharging, and goods can be loaded direct into the railway wagons, which run alongside the quays.

There is an area totalling about 34 acres of acquired and reclaimed land at the disposal of the Harbour Commissioners for extending the port accommodation. Up to the present, however, the Commissioners have not come to any decision with regards to post-war development plans.

Dock Medical Centres

Report on Work at Merseyside and Clydeside

In the course of a report by Dr. E. R. A. Merewether, Senior Medical Inspector of Factories, included in the Annual Report of the Chief Inspector of Factories for 1944, published on November 30th, it is stated that the dock medical services established in the Merseyside and Clydeside areas have continued to develop and are an unqualified success.

They are examples, the Report says, of what can be achieved by concerted working arrangements and cordial co-operation between the dock authorities, local authorities, the local hospitals and general practitioners with the medical and nursing staffs of the docks. The help given by the Ministry of War Transport in the development of the schemes and the joint efforts of the employers and unions concerned in ensuring successful day to day operation of the services should also not be forgotten.

The magnitude of these schemes may be illustrated by some figures of the first year's work of the Liverpool section. A grand total of 23,715 cases, of which 9,034 were new cases, were dealt with at the three dock centres on the Liverpool side of the Mersey. Only one of the centres was in operation for the full 12 months, the other two for seven months only. Of the new cases dealt with 68.5 per cent. were dockers, 11.5 per cent. ship-repairers, 10.6 per cent. Docks and Harbour Board employees, and 9.3 per cent. transport workers, forces, canteen workers, and others. Six hundred and ninety-four cases were referred to adjacent hospitals with whom mutual working arrangements had been made; 252 of these were suspected injuries to bones. One hundred and fifty-seven medical cases were referred to the workers' private medical attendants, accompanied by letters explaining the circumstances of the cases. Further developments are in progress to extend the service to the Birkenhead side of the river, and consideration is being given to the special health problems associated with handling of certain types of cargo.

Similar excellent results are obtained at the Clydeside and Manchester sections: each has its own special problems and has developed appropriate methods of dealing with them. Liaison is maintained between the three sections and, for example, the Liverpool section makes use of the special rehabilitation facilities provided by the Manchester section. Attention is paid to education of the workers in health matters, and the nursing staff give indispensable advice to the women workers. In the Clydeside area special methods have been evolved for dealing with cases suffering from industrial fatigue.

Progress has been slow in the development of similar services in the other dock areas, not from lack of effort and will on the part of people concerned, but from unexpected difficulties in arranging the services consequent on the organisation of these other dock areas being different from the three mentioned above. Surveys have been made, however, and much preliminary work carried out. The complexity of the problem in the vast London area will easily be appreciated.

*Sheet-Piling in Maritime Works**

By SAVILE PACKSHAW, B.Sc. (Eng.), M. Inst. C.E.

Materials

Sheet-piling has been used since the earliest days of civil engineering; its main field of application has always been, and is likely to remain, in maritime works—such as quays and wharves, locks, cofferdams, sea-defence walls, breakwaters, the protection of foundations against erosion, and so on.

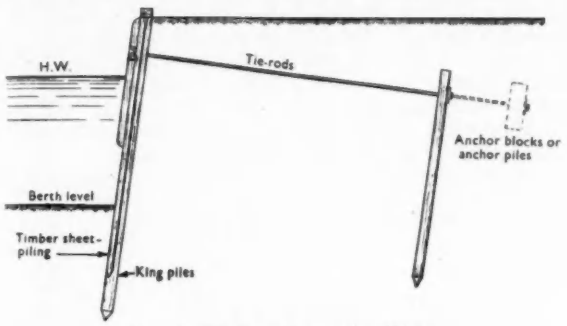


Fig. 1.—Timber Sheet-Pile Wharf

The first material used for sheet-piling was naturally timber and, although this is becoming obsolescent, it is still employed on a fairly large scale for wharves and groynes; no economical and effective substitute for timber in the construction of groynes has, in fact, been found up to the present. An attempt to introduce another material for sheet-piling was made at the beginning of last century, when several different sections of cast-iron sheeting were produced and used, first at Bridlington and subsequently in several docks in London. A " Memoir on Iron Piling " was published in 1836 in the first volume of the " Transactions " of the Institution. All the designs acknowledged one of the disadvantages of timber sheeting, namely, the absence of a positive joint connecting one sheet to another, and achieved considerable success in overcoming it. The brittleness of cast iron, however, obviously makes it an unsatisfactory material for sheet-piling, especially in view of the violent means commonly employed for driving it into position. There was little further development until the manufacture of rolled-steel sections was commenced in

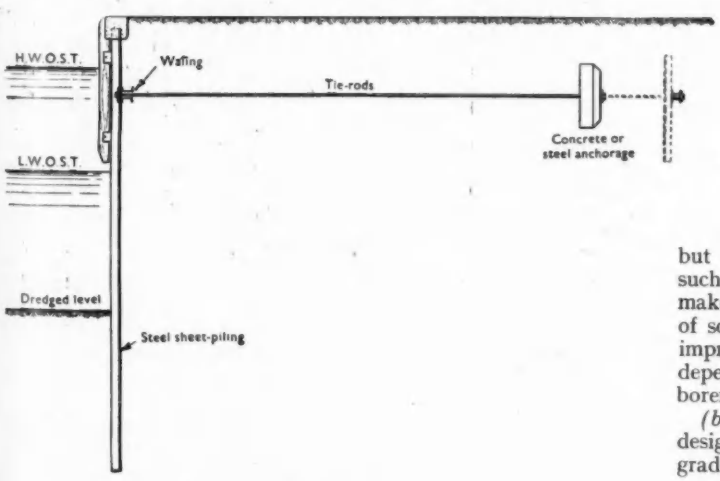


Fig. 2.—Steel Sheet-Pile Wharf

the second half of last century. At first standard channels, joists, angles, and so on were used, sometimes riveted together, but before very long special sections were produced. From the very beginning attention was paid to the provision of an efficient watertight interlock, especially as at that time steel sheet-piling was used mainly for temporary work in cofferdams. Later on the sections were designed to develop a high strength modulus and their application was gradually extended to the construction of retaining walls forming a permanent part of the structure.

The introduction of reinforced concrete was followed by the use of this material for sheet-piling; it is, however, essentially a substitute for timber, and there are only minor differences in the joints or in the shape of sheeting made from these two materials. Attempts have been made from time to time to provide reinforced-concrete sheeting with some form of interlock instead of the usual butt or V-joint, but these have not been applied very extensively either for technical or for economic reasons.

Relative Merits

A brief comparison of the three materials can be drawn up, as follows:—

(a) Timber sheeting is cheap and plentiful in normal times,

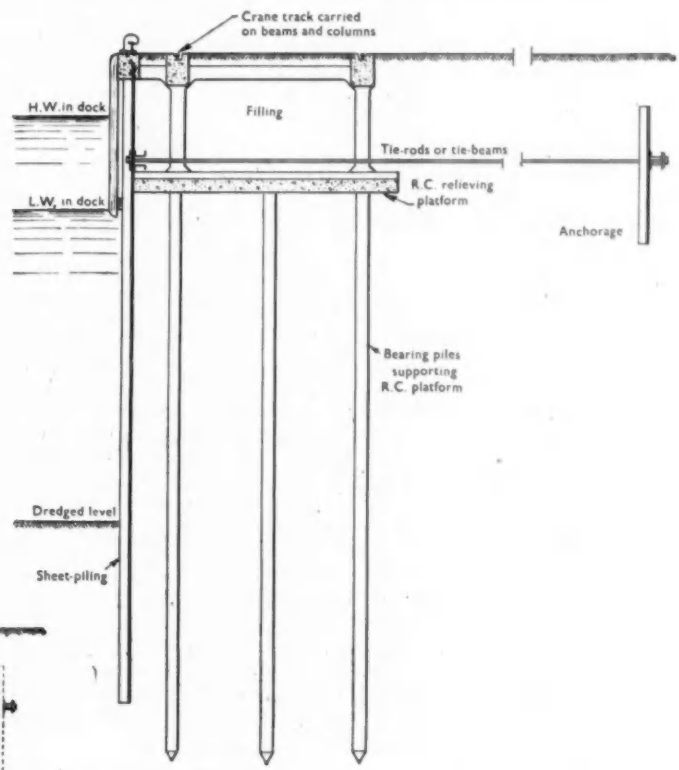


Fig. 3.—Quay Wall with Heavy Superload

but is not very strong; it is difficult to drive into compact soils such as sand or gravel. The absence of an efficient interlock makes it unsatisfactory when its function is to prevent the escape of soil or water through the wall. It can be very durable when impregnated with a preservative and permanently submerged, depending on the type of timber and the activities of marine borers.

(b) Reinforced-concrete sheeting is economical and can be designed for any desired strength; when made from carefully graded and deposited concrete it is very durable, especially if the concrete is vibrated, though some soils, such as peat or clays containing gypsum, may have a detrimental effect. Concrete sheeting is, however, also difficult to drive into compact soils and may be damaged in the process; it is much heavier than timber and consequently requires a larger hammer and heavier plant for driving it. The absence of a positive interlock is a disadvantage in some circumstances, as in the case of timber.

(c) Steel sheeting possesses a positive watertight interlock, but

*Introductory Note to Discussion at the Institution of Civil Engineers, 15th May, 1945. Reprinted by permission.

Sheet-Piling in Maritime Works—continued

is generally more costly than timber or reinforced concrete. There is some uncertainty about its durability, especially of light sections, when an effective life of more than a few decades is required. Sections with a high strength modulus are obtainable. It will penetrate easily into any subsoil except rock; the plant required for driving it is relatively light and the driving cost is low.

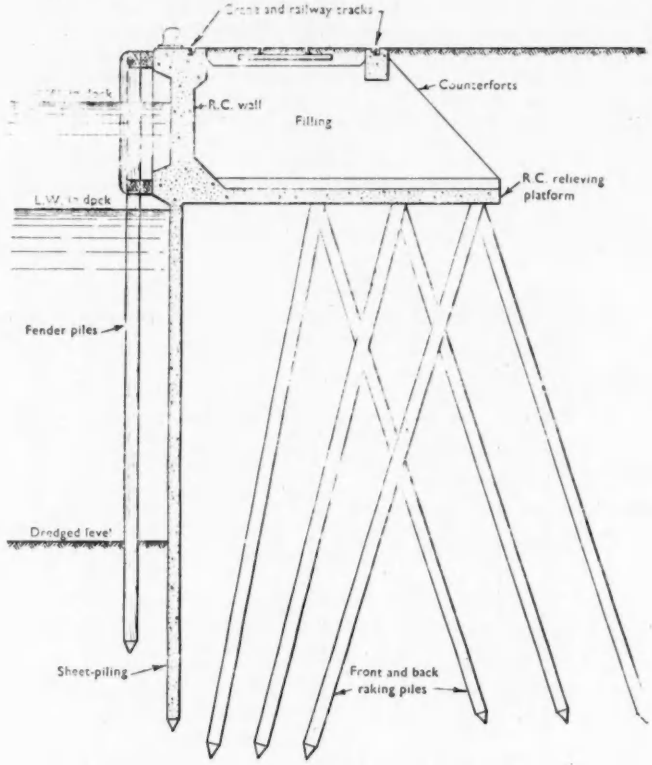


Fig. 4.—Quay Wall with Relieving Platform on Raking Piles

Strength and Stability

Very small sheet-pile retaining walls are sometimes left unsupported, so that they act as vertical cantilevers fixed in the ground, but in the great majority of cases the sheeting is held near the top by tie-rods or other means of restraint. The design must guard against the possibility of failure due to the following causes:—

(a) Penetration of piling insufficient to develop the necessary earth resistance.
(b) Sheeting overstressed, owing to an inadequate estimate of the earth pressure, excessive superload, dredging below the intended level, etc.
(c) Tie-rods of insufficient strength or inadequately protected against deterioration in soils with corrosive constituents, such as ashes.
(d) Anchorage too small or not deep enough.
(e) Anchorage too near retaining wall, being located within the unstable wedge of soil that forms behind the wall.
(f) Shear strength of soil behind and under the wall insufficient, thus permitting the wall, together with the surrounding soil, to fail by rotating and sliding forward.

The most common of these potential causes of failure are (*a*), (*c*) and (*e*). Failure of the material from which the sheeting is made is not frequent, possibly because excessive stresses may be concealed by the factor of safety. Condition (*f*) can be obtained only in very soft clay and is much less likely with sheet-pile walls than with gravity or reinforced-concrete walls, as the former usually penetrate to a much greater depth.

The earth pressure on any retaining wall, as is now well known, is to some extent dependent upon the manner in which the wall deflects or yields to the pressure. Both the magnitude of the pressure and the position of the centre of pressure may be affected; for instance, a timbered trench securely held by several settings of struts is likely to induce a slightly greater earth pressure than a gravity wall. In an anchored sheet-pile retaining wall there is a further complication due to the flexibility of the wall, which tends to reduce the bending moment in the sheeting. Stroyer's work has shown that with cohesionless materials the bending moment may be reduced by as much as one-half or even more, provided the deflexion amounts to at least 0.5 per cent. of the span. Flexures of this magnitude are generally attained with steel and reinforced-concrete sheeting. The results of Stroyer's work are not yet, however, universally accepted, though in Denmark, for example, rules have long been in existence for reducing the calculated bending moment by a flexibility factor. There have been no investigations to determine whether cohesive soils have a similar effect on the bending moment, but it seems probable that any reduction is very much smaller.

Types of Construction

The earliest and one of the simplest applications of sheet-piling to marine work, apart from the plain un-anchored cantilever wall, is illustrated in *Fig. 1*. This is well known and has been used extensively, first in timber and later in reinforced-concrete, especially when firm soil such as gravel or firm clay can be reached by the " king " piles. Sometimes the sheet-piling is replaced by horizontal sheets laid behind the king piles, but this is not satisfactory as the sheets do not penetrate much below the river bed and therefore permit seepage of material from behind the wharf.

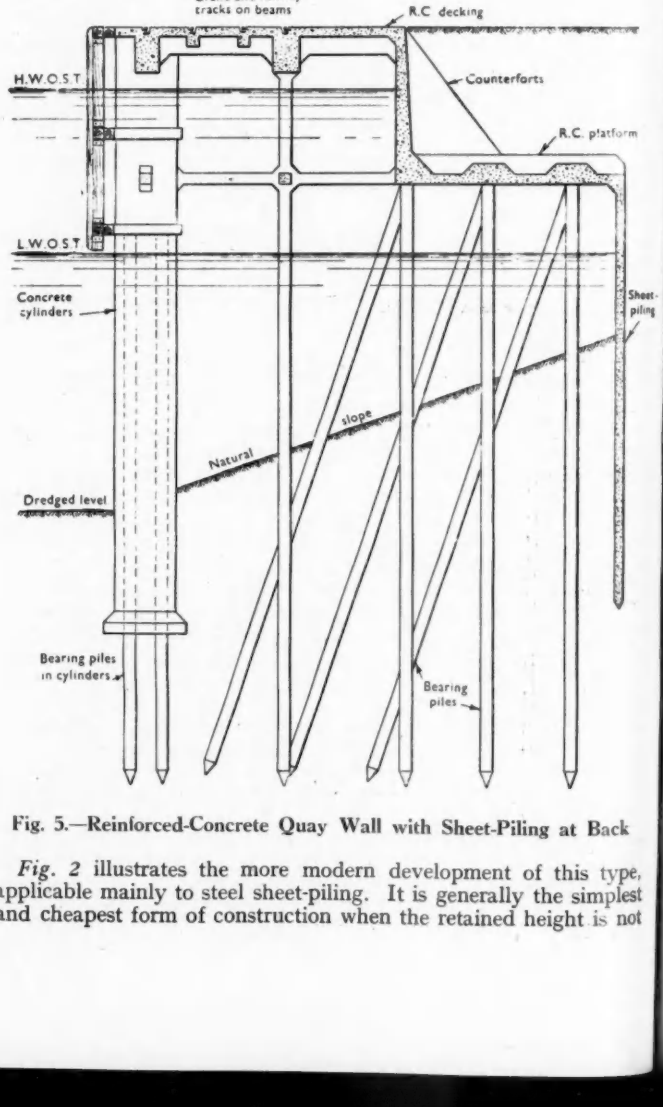


Fig. 5.—Reinforced-Concrete Quay Wall with Sheet-Piling at Back

Fig. 2 illustrates the more modern development of this type, applicable mainly to steel sheet-piling. It is generally the simplest and cheapest form of construction when the retained height is not

Sheet-Piling in Maritime Works—continued

more than about 35 feet to 50 feet, depending on the quality of the subsoil and the loading on the quayside. Independent bearing piles are generally provided to support heavy crane tracks, but railways and light cranes can be carried directly on the ground.

For greater heights, or when large superloads have to be dealt with, it may be necessary to reduce the load on the sheeting by a reinforced-concrete relieving platform, as in *Fig. 3*. This transfers the whole of the superload directly to the bearing piles, so that it does not affect the sheet-piling; the platform also screens the sheeting from part of the earth pressure. The top of the wall is held by means of one or sometimes two sets of tie-rods fixed to anchor blocks or to an anchor wall.

If the soil is of poor quality and cannot be relied upon to develop sufficient resistance for the anchorage, or if long tie-rods are inconvenient, the design of *Fig. 4* may be adopted. Here the top of the sheet-piling is again held by a reinforced-concrete relieving platform, but the horizontal forces necessary to restrain the sheeting are combined with the vertical forces derived from the weight of the filling and superstructure, so as to produce compression in the front rakers and tension or compression in the back rakers.

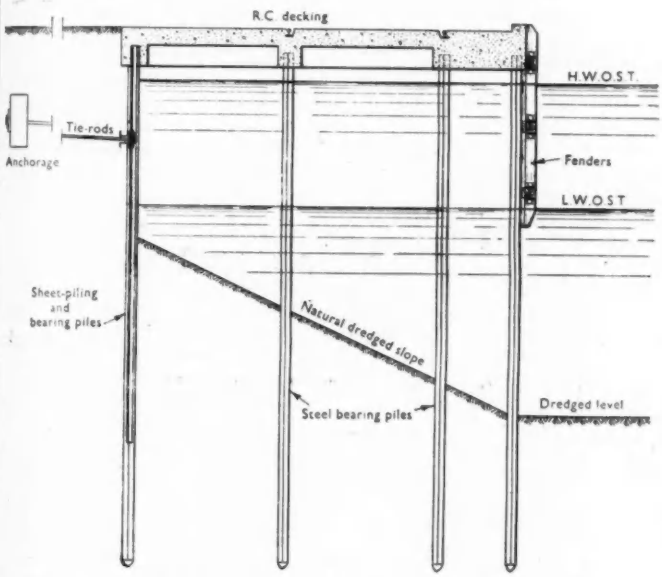


Fig. 6.—Wharf with Front Decking on Steel Bearing Piles

A modification of this form of construction which has not been used much, though it seems to have much in its favour, could be applied to very deep walls. If the bending moment in the sheeting is so high that reinforced-concrete sheeting becomes too cumbersome and no steel-pile section of sufficient strength can be obtained, even if stiffened with riveted or welded plates, two lines of sheeting of moderate size can be provided and driven a few feet apart, the space between them being filled with concrete. This can be deposited under water, so long as provision is made to develop the necessary shear and to ensure that the two lines of sheeting act monolithically with the concrete.

Where the soil forming the harbour bed is of such quality that it is stable at a reasonable slope, it may be more economical to locate the sheeting at the back of the quay. The section and the length can then be reduced by taking advantage of the smaller retained height, as illustrated by *Fig. 5*. The open piled construction also has the advantage that in tidal rivers there is less obstruction to the flow, and this is often the deciding factor in its selection. On the other hand, the structure is less sturdy than those of *Figs. 3* and *4*, and is not so well able to withstand the impact of ships. For that reason, or when the bearing value of the subsoil is insufficient, concrete-filled cylinders are frequently used in place of bearing piles.

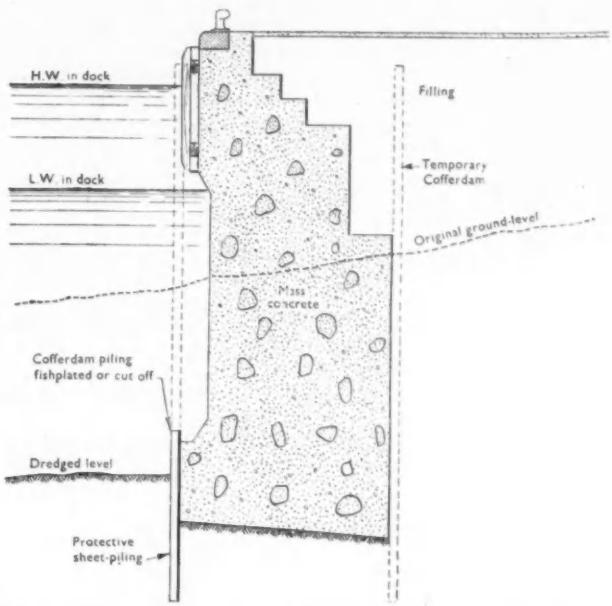


Fig. 7.—Mass Concrete Quay Wall Constructed Inside Cofferdam

A very sound and simple type of wharf is shown in *Fig. 6*. In this there are two virtually separate structures: the false quay on bearing piles or on cylinders, which has to withstand mainly vertical loads, apart from the relatively small lateral forces due to the impact of ships; and the retaining wall at the back, which is subjected only to horizontal earth pressures and earth resistances.

Fig. 7 shows a heavy gravity wall constructed with a cofferdam, the top lengths of the sheeting being removed by burning off under water or by fishplating after the wall is complete, the bottom lengths being retained in position to improve the bearing value of the ground or as a protection against erosion. Many other applications of sheet-piling to quays and wharves can be devised, according to the conditions and the preferences of the engineer; one other type is worth mentioning, namely, that shown in *Fig. 8*, in which a concrete or masonry gravity wall is protected by a curtain of sheet-piling. More often than not this is done to permit dredging to a greater depth than the original wall can withstand. It is generally more satisfactory to take the sheeting up to the top of the wall and to tie it back to an anchorage.

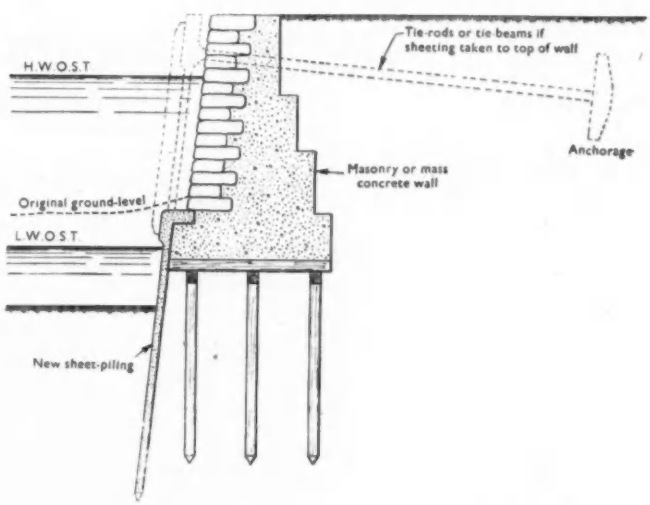


Fig. 8.—Mass Concrete Wall with Sheet-Pile Curtain

Sheet-Piling in Maritime Works—continued

Other types of marine structures in which sheet-piling is of primary importance are moles or breakwaters and the sea wall shown in *Fig. 9*. In this the sheeting performs the essential function of protecting the wall from undermining where there is danger of erosion of the beach.

Future Investigations

There is much scope for investigating the behaviour of completed retaining walls, particularly as regards the stresses and deformations that they develop. Several lines of approach can be suggested. In the case of an ordinary anchored wall it is a simple matter to measure the actual load in the tie-rods by means of extensometers, manholes or pits being left in the filling to give access to the rods after the work is completed. Pressure-cells could be devised and installed in the sheeting at various levels, so as to permit the earth pressure to be measured all the way down the wall; the results could then be compared with the theoretical earth pressure and its assumed distribution. The provision of strain indicators in the sheeting and, where practicable, measurements of the deflexion, would provide a check on the

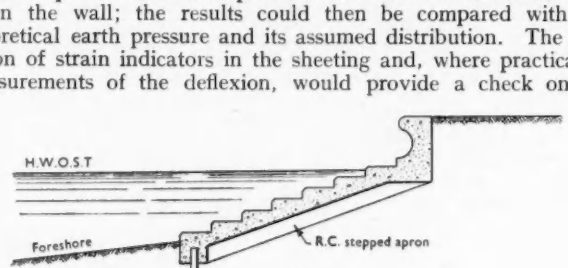


Fig. 9.—Sea Defence Wall

calculated bending moment and show the extent to which it is affected by the flexibility of the sheeting in different soils. The effectiveness of driving the piling deep enough to ensure that it acts as a beam "fixed" in the ground by the earth resistance in front of and behind it, and not "freely" supported, could also be ascertained.

Observations should be commenced immediately after the completion of the wall and continued for a considerable period. This applies particularly to clay soils or walls with clay backing, which may take years to reach final equilibrium.

Practically nothing has been done up to now to obtain answers to these questions. This is partly due to the fact that in many sheet-pile walls the calculation of the earth pressures is complicated by the presence of the remains of old structures, bearing piles, and so on. The main difficulty, however, has been that the design of the wall is dependent upon a reliable assessment of the soil properties. In recent years the study of soils and the technique of soil-testing have advanced sufficiently to establish the relation between theory and practice with a fair degree of accuracy, at any rate in straightforward circumstances. The time therefore seems opportune to institute research as outlined above and to make provision for the necessary measuring devices when the walls are being designed and built, so as to have the means of observing their behaviour when they have been completed.

(To be continued)

Clyde Trust Official's Retirement

Mr. James Logan, assistant secretary of the Clyde Navigation Trust, retired from the service of the Trust at the end of the year. At a meeting of the Trust on December 4th, Mr. William Cuthbert, the chairman, stated that Mr. Logan joined the service in 1897. He became chief clerk in the general manager's office in 1922 and had been assistant secretary since 1940. His knowledge of the affairs of the Trust had been of the utmost value, and he was well-known throughout the city.

Port Administration in Eire

The Eire Harbours Bill, 1945, has been given its second reading in the Irish Dail. The Minister for Industry and Commerce, who introduced it, said the Bill was based on the recommendations of the Ports and Harbours Tribunal of 1930. It applied to the four main harbours of Dublin, Cork, Waterford and Limerick and to 21 other specified ports to whose number Buncrana has been added.

The main provision of the Bill was that the Department should be given general oversight of harbour administration and that a fresh policy should be adopted to the end that the various harbour undertakings might be brought to the highest level of efficiency. Harbour administered by the Office of Public Works or under or managed by county councils and railway companies were not covered. The general scheme now prepared recognised that the management of ports and harbours was largely a matter for local authorities. The four main harbours would have Boards with memberships of 15 each and the others would consist of 9 or 11.

In the case of the main ports five members would be appointed by the corporations, four by chambers of commerce, two elected by persons paying tonnage rates of £20 or over, and four nominated by the Minister for Industry and Commerce, one of whom would represent labour interests. The Bill would thus reduce the membership of the Dublin Port and Docks Board from 28, as at present, to 15. Other harbours affected by the Bill include Arklow, Drogheda, Galway, Sligo, Annagassan, Ballyshannon, Buncrana, Baltimore, Skibbereen, Dingle, Dundalk, Foynes, Killybegs, Kilrush, Kinsale, River Moy, New Ross, Tralee, Fenit, Westport, Wexford, Wicklow and Youghal. For the above harbours the authorities would comprise four members appointed by the local authorities, two appointed by chambers of commerce (where such exist), two elected by persons having tonnage rates of £10 or over, and three nominated by the Minister, one of whom would represent labour interests. The term of office of all harbour authorities will be three years. The Minister will have power to remove any harbour authority from office if satisfied, after an enquiry, that the duties are not being duly and effectively performed, and on certain other specified grounds.

The Bill also provides for a superannuation scheme, on a contributory basis, for the benefit of officers and established staff. A register must be made by the harbour authorities of all casual labourers employed, and employment is to be confined to workers so registered. The harbour authorities will be empowered to provide facilities in their harbours for aircraft, and subject to the consent of the Minister, may make charges for such facilities, and enter into agreements for the use of their harbours as aircraft landing areas. The Minister will have power to authorise authorities to construct works, and acquire lands compulsorily.

The auditor for each harbour will be appointed by the Minister who will have power to make regulations in regard to the accounts to be kept by an authority. Authorities may also, subject to the Minister's approval, borrow on the credit of their harbours; and a local authority, with the consent of the Minister for Local Government, may assist a harbour authority by guaranteeing a loan, or by borrowing sums required by that authority. The Bill also provides that the Minister may make orders declaring that the water bailiff's fees, chargeable at Waterford Harbour, the dues known as the city dues chargeable at Dublin Harbour, and the cocket and entry tax chargeable at Cork, shall cease to be charged or levied.

Engineering Appointments Bureau

The Professional Engineers Appointments Bureau invites applications for registration for employment from members who, by reason of their engineering qualifications, belong to The Institution of Civil Engineers, The Institution of Mechanical Engineers, or The Institution of Electrical Engineers, or persons whose engineering qualifications for election or admission to one of those Bodies have been approved by the respective Councils. The necessary forms may be obtained on application to the Registrar of the Bureau, at 13, Victoria Street, Westminster, S.W.1. A stamped addressed foolscap envelope should be enclosed.

The Dock Labour Wages Agitation

Report of the Evershed Committee of Enquiry

The Committee of Enquiry into the claims of dock workers for an increase in their daily rate of pay from 16s. to 25s., appointed by the Minister of Labour and National Service on November 29th, and consisting of Mr. Justice Evershed (chairman), Sir Frederick Rees, Professor J. W. MacDonald, Mr. F. N. Hepworth and Mr. J. C. Little, issued their Report on December 11th. It was in the following terms.

The Report

At a meeting of the National Joint Council for the Port Transport Industry on September 27th, 1945, the trade union side submitted to the employers' side a claim under three heads, the first including the claim that the basic rate be increased from 16s. to 25s. per day; the minimum to be on the daily basis instead of the half-daily basis. Protracted negotiations took place as a result of which a measure of agreement had been reached on the other claims, but it had proved impossible to reach any agreement on the question of increasing the national minimum wage and the pieceworkers' minimum guarantee—which it was agreed should be (as it had always been in the past) at the same figure.

2. For the unions, reference was made to the history of the industry and to the dockers' wages before and after the Shaw inquiry; to the claim submitted in 1937 which resulted in the wage increase of 1s. in October, 1939, such increase (it was claimed) not being in the circumstances properly a war-time increase; to the effects of the introduction of mechanical appliances; to the record of the dockers during the late war; to the peculiar circumstances of dock labour and the variety of work which the docker was called upon to do.

Mr. Deakin and Mr. Donovan (who spoke on behalf of their Unions) estimated that the 74,000 dockers registered in the dock labour schemes could not expect more than four days' full-time employment per week, and on that basis urged that a daily minimum of 25s., or 100s. per week, was not excessive and would not tend to inflation.

In reference to the claim to make any wage increase retrospective attention was drawn to the high feeling recently caused, which was attributed to delay in dealing with the present claims.

3. For the employers, reference was made to the total number of men employed by them of which the present claims concerned only about one-tenth, and to their obligation to importers and exporters and to the public; to the fact that since the time of the Shaw Inquiry the "casual" character of the industry had been considerably modified; to the existing labour schemes and the proposed decasualisation; to the encouragement of piece work and the high piece-work earnings; to the effect of overtime port differentials and contingencies on actual earnings; and to the fact that under-employment in the past had been due to excessive numbers of men available for work. In reference to the claim to make any wage increase retrospective, the employers denied responsibility for delay. Sir Robert Letch (speaking on their behalf) put in evidence documents showing average earnings for various periods and an analysis of wages in the Port of London for the week ended October 6th, 1945.

4. Mr. Deakin and Mr. Donovan replied to the arguments adduced by the employers, and challenged many of the figures and the conclusions sought to be drawn therefrom.

5. For the purposes of our Inquiry, it was agreed that the wages recommended, though expressed as a figure "per day," should continue to be operated as heretofore on a half-daily basis.

6. Realising the significance in the public interest of the issues submitted to us, we have considered most anxiously the arguments of the two sides put before us—as they have been—with very great force; and we have reached unanimous conclusions upon them.

7. We do not think it necessary, or useful, to refer in greater detail to the many considerations, properly affecting the matter, to which our attention has been drawn. We mention, however, the fact that the dock industry does differ in important respects from other industries. Though the labour schemes administered by the Ministry of War Transport and the National Dock Labour Corporation have substantially altered the old "casual" characteristics of employment at the docks, it nevertheless remains and must (as we understand it) remain true under existing conditions that the labour forces required to be available at the docks must be such that the men cannot expect full employment for the whole of every working day in the week. We refer also to the fact that in this industry the so-called "national minimum wage" is not merely a minimum wage as commonly so understood, but forms the basis of the entire wage structure of the industry and consequently to the effect of any increase in the time or basic rates on the piece-rates. We refer finally to the bearing of dock wages on the wages of other workers (although under different conditions) at the docks and in other industries.

8. In our view, it would be neither right nor possible for us to disregard the "attendance" moneys which, under and subject to the conditions of the existing schemes operated by the Ministry of War Transport and the National Dock Labour Corporation, are payable to dockers presenting themselves for work for any "turn" on which no work is available for them. We are bound, as it seems to us, to reach our conclusions on the basis of the facts as they are, though the result may be temporary. We therefore emphasise that the conclusions we have reached assume and are conditional upon the continuance of the existing schemes, including registration and including particularly the existing rights to "attendance" payments. If and when these conditions change or these moneys cease to be payable, then the time or basic rates must be reconsidered.

9. Bearing all the above considerations in mind and on the assumptions which we have just stated, we are of opinion that the national minimum wage of time workers and the minimum guarantee to pieceworkers should be increased from 16s. per day to 19s. per day on the half-daily basis.

10. On this basis, a dock worker who obtains employment and is paid on the time basis for the full 5½ days of the week would receive 104s. 6d. If on the other hand (in accordance with the assumption submitted by the unions) he obtains employment and is paid on the time basis for four days and is entitled to "attendance" money for the remaining three turns, his wages would amount to 94s. or 98s. 6d. (according to the scheme applicable). These figures represent, in our opinion, fair rates of wages in all existing circumstances, and the increases involved, compared with pre-war figures, are in our judgment fairly in line with increases which have been applied in other industries.

11. With regard to the date from which the increase which we have recommended should operate, we have carefully considered the submissions of both sides, and it is in our judgment fair and just that the increases we have named should be treated as having come into operation on the first full pay day after November 28th, 1945, being the date on which the decision to appoint the Committee was announced in the House of Commons, and we recommend accordingly.

Recommendations

12. Our recommendations are therefore as follows:—

(a) That the national minimum wage be increased from 16s. per day to 19s. per day, operated on a half-daily basis as heretofore.

(b) That the pieceworkers' minimum guarantee be increased from 16s. per day to 19s. per day, operated on a half-daily basis as heretofore.

(c) That the said increases be treated as having come into operation on the first full pay day after November 28th, 1945.

We desire to place on record our sincere thanks for the assistance we have received throughout our inquiry from Mr. A. F. A. Sutherland, who has acted as our secretary.

In spite of some opposition, the award of the Committee was ultimately accepted by the men at a series of mass meetings convened by the Unions, at which the terms were explained and acceptance advocated.

Notes of the Month

Proposed New North of Ireland Port

A proposal has been made for the creation of a new port at Dunseverick, on the coastline of Antrim, Northern Ireland, between Portrush and Carnlough. The matter was raised in the Northern Ireland House of Commons, when a grant was urged in aid of the project. It is understood that the matter is under consideration by the Government.

Port of Harwich Appointment.

The London and North-Eastern Railway Company announce that Mr. J. E. M. Payne, Assistant to Marine Superintendent Engineer, has been appointed Marine Superintendent Engineer, Parkeston Quay, Harwich, in succession to Mr. R. C. Banks, who has retired from the service.

Death of Former Port Official.

The death is announced of Mr. Alfred Harding, formerly dock superintendent for the North-Eastern Railway, at Tyne Dock, Newcastle-upon-Tyne. He was latterly a member of the River Wear Commission and chairman of the Wear Pilotage Authority. For the last 25 years he had been manager of the railways and coaling staithes at Sunderland of the Lambton, Helton and Gricey Collieries.

Permit Regulations for Export Cargo.

The Permit System in respect of export cargo shipped from Liverpool and Birkenhead, instituted by the Port Emergency Committee on February 24th, 1941, has been cancelled in respect of all ships loading at Liverpool or Birkenhead from January 1st, 1946. As from this date the calling forward of export cargo has been in the hands of the Shipping Conferences or Companies whose requirements will be indicated to Shippers in due course.

Reconstruction of Wharf at Dundee.

A plan for the reconstruction of the Western Wharf at the Port of Dundee has been approved by the Dundee Port Trust. The work which is estimated to cost £200,000 will be carried out under the supervision of the Trust Engineer. Preliminary borings are to be undertaken by a London firm at a cost of £3,500.

Mersey Dock Board Appointments.

Two important appointments have recently been made by the Mersey Docks and Harbour Board, viz., Mr. Mark R. Preston, M.B.E., as Deputy General Manager and Secretary, and their Chief Traffic Manager, Mr. F. H. Cave, as Assistant General Manager.

Mr. Preston's service covers nearly 50 years. His zeal brought him into prominence early in his career for shortly after he had served his apprenticeship he was appointed Personal Secretary to the then General Manager, Mr. Miles Kirk Burton. He received his M.B.E. in recognition of his work as Secretary of the Liverpool Committee for co-ordinating Naval, Military and Civil requirements during the first world war, and he became an Assistant General Manager in 1938, following the appointment of Mr. R. J. Hodges as General Manager and Secretary and the retirement of Sir Lionel A. P. Warner, C.B.E.

Mr. Cave, who will act jointly with Mr. Charles Ree as Assistant General Manager, succeeded the late Mr. Albert Foulkes as Chief Traffic Manager in 1937. He received his training in transport through the Ministry of Transport, and his first connection with Liverpool was just before the general strike in 1926, when, as Assistant Road Commissioner, he organised the services for foodstuffs throughout the North-west and North Wales.

In the capacity of Chief Traffic Manager Mr. Cave's Department was responsible for the clearance of the dock quays and the rapid dispatch of cargo through the Port during the war years. He is a member of the Port Emergency Committee and Chairman of the Sub-Committee appointed to deal with the allocation of transport. Shortly before "V.E." Day he paid a visit to America to inspect American Port operations and appliances.

Developments at Port of Boston.

The sum of fifteen million dollars has been authorised by Governor Tobin of Massachusetts, U.S.A., to be expended on the development and modernisation of Boston Harbour.

Wick Harbour Trust Finances.

Wick Harbour Trust have decided to make application for a grant from the £15,000,000 fund which the Government is allocating to distressed areas. The chairman of the Trust pointed out that the Harbour Debt would remain for years to come unless paid off by some such arrangement.

Institution of Civil Engineers

The Presidential Address of Sir T. Peirson Frank, Chief Engineer of the London County Council, to the Institution of Civil Engineers was delivered on Tuesday, November 6th. The address was concerned with the advance preparations undertaken by the County Council to meet the contingencies of the late war and the subsequent operations performed to maintain the life of the civic community.

Luanda Harbour Works

Information has been received that the new quay walls at the Port of Luanda, a descriptive article on which appeared in the issue of November last, were brought into commission on June 29th, 1944, the inaugural ceremony being performed by the Portuguese Minister of Colonies. The building of warehouses and the equipment of the port is proceeding.

Development of Ionian Port

A new town-planning scheme for the town of Corfu, on the Ionian island of that name, includes a reconstruction plan for the port, or rather its replacement by a new port to the west of the pre-war anchorage, commencing at the point of the new port, opposite the middle of the Western Breakwater, and extending along the front of the Manduchio suburb to Kephalomanduchio. The existing section of the old breakwater will be prolonged in a north-by-west direction, so that the entrance of the new harbour will face east, with a depth of about 8 fathoms. A mole is projected west of Port Abraham, upon which will be built modern Customs' warehouses, passenger examination halls, etc. Along the Manduchio sea-port, berths are designed for cargo steamers with adequate storage, and further to the west there are to be cattle pens and an up-to-date fishery harbour.

Proposed New Australian Graving Dock.

According to the Melbourne *Herald* the Government of the State of Victoria have under consideration a proposal for the construction at Melbourne of a graving dock, estimated to cost £1,500,000.

Mr. Dunstan, Premier of Victoria, first made a request to the Commonwealth for a large dry dock for Melbourne in 1943. He has renewed his request and has pointed out that such a dock would not only help to consolidate the shipbuilding industry, but would form an integral part of the modern ship-repairing facilities proposed by the Melbourne Harbour Trust. Mr. Dunstan told the Commonwealth Government that instances had occurred of vessels being damaged in Southern waters and proceeding beyond Melbourne because of the lack of docking facilities.

Mr. Chifley, Prime Minister of Australia, in reply to the request, said that the Commonwealth interest was governed by the need for additional dry docking facilities in Australia, and so far as merchant shipping was concerned the end of the war would cause a marked decline in the use of dry docks. Facilities in Australia were at least 50 per cent. greater than before the war, and Commonwealth shipping departments were of opinion that there were sufficient docks. For naval vessels there was a possibility that a medium-sized dry dock, suitable for cruisers, would be a useful facility. Asking for further details of the plans, Mr. Chifley said that in any event an investigation would be made into likely strategic requirements for shipping.

Clyde Port Amalgamation

Scheme for New Port Authority for Clyde Area

The Clyde Estuary Committee appointed in August, 1944, under the chairmanship of the Rt. Hon. Lord Cooper, "to enquire into the present arrangements for the provision and administration of navigational facilities and of docks and harbours of the River and Firth of Clyde and the locks leading from them, and to report what modifications, if any, in those arrangements are desirable for the promotion of the trade of the estuary and the public interest," has issued a report of 46 pages with three appendices and a map, which is about to be published by H.M. Stationery Office.

In addition to Lord Cooper, the Committee consisted of Sir Robert Letch, former Regional Port Director for Scotland, and Mr. Robert Taylor.

The report comprises two parts. In Part I have been summarised the main facts of the present position and the Committee's estimate of the probable trend of requirements in the predictable future. Part II contains the Recommendations based on this survey.

The following extracts from Part II are an embodiment of the principal Recommendations.

Committee's Conclusion

The conclusion which, at the end of the day, we have reached without hesitation is that the time has come for a substantial measure of unification on the Clyde, and that this should be achieved by replacing existing authorities in the River and Upper Estuary by a single new authority, to be known as the **Clyde Port Authority** (or other suitable title), which will exercise the full powers of a modern port and harbour authority within the area above Cumbrae Heads and will enjoy certain limited powers in the lower Estuary. We contemplate that this new Authority will, either at once or after an interval, acquire the assets and assume the liabilities of the existing undertakings (with certain exceptions), and will be charged with the duty of maintaining, improving and developing the river and estuary and their navigable potentialities in the general interests of the West of Scotland and of the country as a whole, collaborating as far as practicable with the central and local authorities and join land transport undertakers in all schemes for the improvement, expansion and re-development of the industrial hinterland served by the Clyde.

RECOMMENDATIONS

Composition of the New Authority

1. If all the bodies and authorities on whose behalf claims to representation have been lodged were to be given the representation which they ask, the size of the new authority would be inflated to a point at which it would cease to be a workable executive authority, and would be converted into a sizeable deliberative assembly composed of representatives from every major interest in the West of Scotland. Having before us the example of many of the principal ports of the world, and of the governing bodies of the great transport, industrial and commercial enterprises of the United Kingdom, both public and private, we consider that nothing is to be gained, but much to be lost, by proceeding on any such lines. The aim should not be the setting up of an assembly of delegates appointed to push the claims of local or sectional interests and dependent upon their principals for instructions, but the creation of a united executive board, with the single purpose of improving and developing the River and Estuary in the general interest, and composed of persons of the widest possible experience and knowledge of trade, industry, transport and public affairs in Scotland, each of whom will make his own distinctive contribution to the work of the authority. To attain this end with efficiency, while at the same time showing due respect for the traditional methods hitherto adopted on the Clyde in relation to port administration, we recommend that the new authority should be restricted to twenty-one members, chosen as after-mentioned.

2. The members should give their services without remuneration, though it may be found that a salaried full-time chairman may be advisable. We suggest that an age limit of 70 at the time of election or appointment should be applied.

3. Predominant representation should be given to trading interests and to persons chosen by the payers of rates and dues, by whom the ordinary revenue of the undertaking is paid and who have the most direct interest in its efficiency.

Upon this footing, the general scheme which we recommend is as follows:—

1 appointed by the Admiralty.

2 appointed by the Minister of War Transport (or his peacetime successor) and the Secretary of State for Scotland, jointly, of whom one shall be representative of the shipbuilding industry within the area.

1 appointed by the Minister of Labour after consultation with organised dock labour working on the undertaking.

12 elected by payers of dues and rates, on a franchise similar to that now in operation, 6 in respect of goods and 6 in respect of ships.

4 appointed by Glasgow Corporation.

1 appointed by Greenock Corporation.

21

Experience has shown, as indeed is obvious, that time is needed to enable a member of such an authority to gain the practical experience required to enable him to make his due contribution, and we therefore suggest that the period of office should be five years and that retiring members should be eligible for re-appointment or re-election.

Area of the New Authority

We consider that the new authority should be in the full sense the port authority for the river and upper estuary and its tributary lochs from Albert Bridge, Glasgow, as far down as the Cumbrae Heads, and that the most convenient boundary line would be that prescribed for the Clyde Lighthouses Trust, viz., a line approximately east and west through the southmost point of Little Cumbrae, from Skipness to the Ayrshire coast.

This division line will give the new authority the area, with its approaches, within which the vast bulk of the present and prospective traffic will be found, and which constitutes in a maritime sense an area distinct from the lower estuary. It is the area suggested as appropriate by most of the affected interests.

It is true that by adopting this line we have excluded Ardrossan, Irvine, Troon and Ayr, in addition to many smaller harbours, but we have done so deliberately. The main risk to be guarded against in the outer estuary is the possibility of new developments at the existing ports, or at any projected new port, which might adversely affect the plan for the estuary as a whole, and provision for this risk must be made. To meet this possibility, we have made certain recommendations which, in our view, will adequately safeguard the position.

Undertakings to be Absorbed

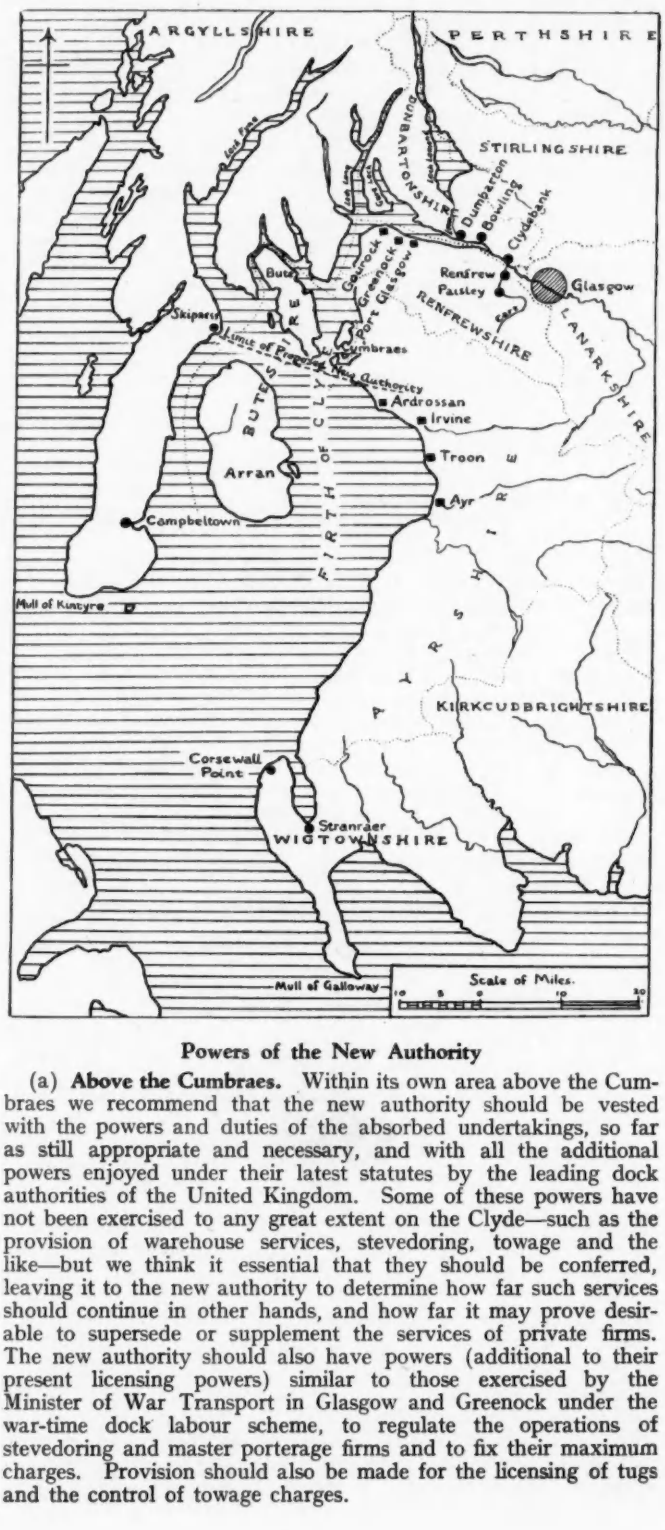
Our conception is that there should from the first be incorporated in the new undertaking, and that there should pass under the initial transfer, at least the undertakings of the Clyde Navigation Trust, the Clyde Lighthouses Trust and the Greenock Harbour Trust, and the functions of the Clyde Pilotage Authority; and that the new authority should be empowered to acquire by agreement any of the other dock, pier or harbour undertakings within the area above the Cumbraes. Failing such agreement, we suggest a provision on the lines of s. 10 of the Port of London Act, 1920, empowering the new authority to acquire any of these other undertakings compulsorily by provisional order.

In our view the railway passenger piers at Craigendoran, Gourock, Wemyss Bay, Largs and Fairlie should, for the present at least, continue to be operated and controlled by the respective railway companies; and this could be achieved either by deferring the power to acquire these piers, or by an agreed token transfer and re-transfer under licence. We anticipate no difficulty in the

Clyde Port Amalgamation—continued

adjustment of the matter between the railway companies and the new authority.

We do not contemplate an immediate transfer of the small harbours and piers above the Cumbraes on the coasts of Bute, Argyllshire and Dumbartonshire, for they do not constitute a part of the port facilities of the Clyde, but have rightly been made the subject of a different administrative and financial policy.



Powers of the New Authority

(a) **Above the Cumbraes.** Within its own area above the Cumbraes we recommend that the new authority should be vested with the powers and duties of the absorbed undertakings, so far as still appropriate and necessary, and with all the additional powers enjoyed under their latest statutes by the leading dock authorities of the United Kingdom. Some of these powers have not been exercised to any great extent on the Clyde—such as the provision of warehouse services, stevedoring, towage and the like—but we think it essential that they should be conferred, leaving it to the new authority to determine how far such services should continue in other hands, and how far it may prove desirable to supersede or supplement the services of private firms. The new authority should also have powers (additional to their present licensing powers) similar to those exercised by the Minister of War Transport in Glasgow and Greenock under the war-time dock labour scheme, to regulate the operations of stevedoring and master porterage firms and to fix their maximum charges. Provision should also be made for the licensing of tugs and the control of towage charges.

Without prejudice to the rights of the Ministry of War Transport in relation to works below high-water mark, we also consider that the owners of all existing but unabsorbed pier or harbour undertakings above the Cumbraes should be laid under a statutory obligation: (a) to maintain the works to the reasonable satisfaction of the new authority, in so far as they may affect navigation; (b) to obtain the licence of the new authority for any additions, extensions or new construction below high-water mark; and (c) to comply with the regulation of the new authority as regards user of the works to prevent unfair competition.

(b) **Below the Cumbraes.** It will be sufficient, in our view, to restrict the powers of the new authority in the lower estuary below the Cumbraes to present or future harbour works capable of being used for overseas trade or for coasting trade, other than that of West Scotland. The owners of such existing or projected harbours or docks should be laid under obligation to consult in advance with the new authority regarding new capital works for the provision of additional accommodation for ocean or coastal shipping, and the new authority should be empowered to acquire any such undertaking by agreement, or, failing agreement, to apply by provisional order for powers of compulsory acquisition.

We may observe that we have no cause to think that the railway companies or the authorities at Irvine and Ardrossan will fail to co-operate amicably with the new authority, if only in their own best interests. But on the long view some such provision as we have indicated seems indispensable in order to ensure that the new authority may with confidence proceed to frame and execute its master plan. It may safely be assumed that the new authority would only operate the suggested safeguard with a full sense of responsibility in order to protect the wider public interest against wasteful duplication of facilities and unfair competition.

We may add that we have in view the possibility that the general question of railway-owned docks may again come under review in the future; and if it should be determined to divorce railway docks from the relative railway undertakings, the new authority would be the appropriate body to assume control at Ayr and Troon.

War Emergency Ports at Faslane and Cairnryan

These ports were constructed by the War Department at a critical period of the war as an insurance against the risk of the destruction of the main Clyde ports, and to provide extra deep-water accommodation, and it is only natural that their siting and the provision of communications, equipment and facilities were dictated solely by strategical considerations and the over-riding needs of the war situation. We understand that their eventual utilisation has not been decided upon by the service departments, but if they are to be employed solely for War Office or Admiralty purposes, they can be left out of account in the proposed reorganisation. Owing to their situation, means of access and absence of convenient urban facilities, we do not consider that these two ports could be converted under peace-time conditions into economic commercial port undertakings, but they could become under certain circumstances a source of unfair competition to the existing port authorities or the suggested new authority.

To meet this possibility, the Ministry of War Transport on 20th January, 1942, addressed a letter to the Clyde Navigation Trust assuring them, *inter alia*, that in respect of Faslane, if at any time after the war the Government should decide to discontinue using the port for war materials handled by military personnel, they would not dispose of the facilities to any undertaking other than the Clyde Navigation Trust without consultation and agreement with the Trust.

This assurance, which was repeated in a letter from the Ministry dated 25th May, 1945, meantime safeguards the position, and we suggest that, if our proposals are adopted, a like assurance should apply to the new authority, and that a similar assurance should be given in respect of Cairnryan. We also suggest that, if and when the Service Departments have no further use for the two ports, they should be entrusted to the new authority on terms to be agreed, for care and maintenance and for such limited commercial use as the authority can devise. For example, it was

Clyde Port Amalgamation—continued

represented to us that Faslane could be employed in whole or in part for ship-breaking, and this would be a useful outlet.

Clyde Lighthouses Trust

Under our proposals this Trust, after a long and successful career of useful service, would cease to exist, its functions passing to the new authority. It is quite possible that economies could be achieved by arranging for certain lights, etc., in parts of the new area to be maintained by the Northern Lighthouse Commissioners, and this will require special consideration in connection with the major lights at the Cloch, Toward Point and Little Cumbrae. We understand that no difficulty need be apprehended in adjusting any such transfer. But we can find no reasonable justification for maintaining the Lighthouses Trust as a separate entity under the new regime, for the few functions which would remain to it can equally well be performed by the new authority, with or without the co-operation of the Northern Lighthouse Commissioners.

Clyde Pilotage Authority

We recognise that this is a subject governed by the overriding provisions of the Pilotage Act, 1913, and that it would be *possible* under our proposals for a separate Pilotage Authority to continue in being. But we have failed to discover what public advantage is to be gained by such duplication, or what possible prejudice could be sustained by any interest if pilotage were now confined to a Pilotage Committee of the new authority with added members representative of the licensed pilots. Such a system is familiar enough at other ports. It is obvious that the constitution prescribed for the pilotage authority by the existing order of 1920 has long been out of date, and will in any event require re-casting if our proposals are adopted. Moreover, it is undesirable that two different authorities should be prescribing bye-laws for the same area. It matters little whether this matter is dealt with as part of the general re-organisation or by a further pilotage order. In either event, we advise that the present authority should be superseded by a new pilotage authority consisting of a suitably composed committee of the new port authority with the addition of the proper proportion of licensed pilots.

Dock Labour

We share the hope expressed to us by all parties concerned that the principle of decasualisation introduced on the Clyde and elsewhere during the war will be placed on a permanent basis, but we understand that the plans for the administration of the system in time of peace have not yet been worked out. It seems unlikely that the present scheme, under which the Minister of War Transport is the "legal employer" of dock labour at Glasgow and Greenock, will be adopted as a permanent arrangement; but these are matters on which we are not in a position at this stage to express any view. We content ourselves by stating that, so far as we can judge, the adoption of our unification proposals would interpose no obstacle to the adoption of any permanent administrative scheme, and indeed, that the existence of a single unified authority would probably offer advantages in the setting up of a permanent scheme. In our opinion, the new port authority would be an entirely suitable body to be the "legal employer" of dock labour under any post-war decasualisation scheme.

Customs

We heard certain complaints of inconvenience arising from the separation of the Customs Offices for the Greenock and Glasgow areas. If our unification proposals are adopted, we have no doubt that the Board of Customs and Excise will take any necessary administrative action to adapt their organisation in the manner best fitted to meet the general convenience.

Financial Basis of the Amalgamation

The scheme which seems to us most appropriate is that the constituent undertakings to be transferred to the new authority should be so transferred, with their whole assets and liabilities, the purchase consideration, if any, being an allotment of stock of the new authority of such an amount and description as will afford a just indemnity to the stock-holders or other interests to be compensated.

In some instances, e.g., where there is no outstanding debt and no proprietary interests, all that may be required is a simple transfer of assets and liabilities, powers and duties, without any purchase consideration. We assume, of course, that the customary provision will be made for compensation to staff for forced loss of office, and for superannuation schemes, and the like. In many of the cases, we anticipate that the matter would present no difficulty, but in others, and notably in the case of the Greenock Harbour Trust, the position will inevitably be complex and difficult.

We therefore suggest a scheme on the analogy of the Railways Act, 1921, the London Passenger Transport Act, 1933, and the earlier port amalgamations, whereby an independent arbitration tribunal shall be set up, consisting of an expert or experts to be nominated in the Act or by an independent authority, such as the Lord President of the Court of Session. It will be the duty of this tribunal (a) to approve any agreed amalgamation scheme which way be submitted by the constituent authorities whose undertakings fall to be merged in the new authority; (b) failing such agreement, to settle such a scheme themselves in accordance with the principles referred to below; and (c) to adjust the allocation of the securities to be issued by the new authority in satisfaction of the transfer consideration.

The Necessary Legislation

The bill to give effect to our proposals, if accepted, would follow the general model of the Port of London Act, 1920, adapted on the lines of the Clyde Navigation Acts to local conditions. We trust that it may be possible to supersede entirely the scores of local and private acts by a self-contained and complete code, though we recognise the difficulties of such consolidation.

Under the 1939 proposals, procedure would doubtless have been by way of provisional order promoted by the Clyde Trust. In this instance, we venture to urge that procedure should be by way of a public government bill, as in the case of the original Port of London Act of 1908. It would, in our view, militate against the success of the entire scheme if it had to be initiated in an atmosphere of heated controversy by a private measure promoted by the Clyde Trust as predominant partners in the proposed amalgamation, and opposed, at least formally, by the great number of affected interests; nor would it be fair to the Clyde Trust to force them into such a position.

(To be continued)

Obituary

Inland Waterways generally, and the Trent Navigation Company in particular, have suffered a serious loss by the death on December 8th of **Lieut.-Col. Frank Rayner, C.B.E., D.S.O., T.D.,** director and consulting engineer of the Company in question, of which he was formerly engineer and general manager. A native of Nottingham, he joined the Trent Navigation Company in 1887 as a junior engineer, and became engineer and joint general manager in 1909. In 1909 he was appointed sole general manager, and 20 years later became a director of the Company and consulting engineer. Colonel Rayner was responsible for the carrying out of a variety of improvements on the River Trent, and, among other things, the construction of a number of the locks for navigation purposes. He was a vice-president of the Institute of Transport, a past president of the Canal Association, and an Associate-Member of the Institution of Civil Engineers.

We regret to announce the death of **Mr. W. T. Chamberlain,** a former chief engineer of the Belfast Harbour Board, which took place on December 16th. Mr. Chamberlain, who contributed to this Journal on several occasions, took a leading part in the development of Belfast Harbour, including the construction of the Pollock Dock and of the harbour airport. He joined the staff of the Commissioners in 1889 and attained the position of chief engineer in 1930, holding it till 1943, when he retired

*Lock Manifold Experiments**

By EDWARD SOUCEK, Assoc.M.Am.Soc.C.E. and
E. W. ZELNICK, Jun., M.Am.Soc.C.E.

Synopsis

IN connection with the design of the Third Locks of the Panama Canal, a series of experiments dealing with the hydraulics of manifolds was performed in The Panama Canal Hydraulics Laboratory during 1939 and 1940. This paper presents a summary of the test results. Certain introductory and theoretical material which appeared desirable has been included. A method of predicting the performance of a manifold by the use of single port test data is presented and the method is checked by comparison with manifold tests. Some of the data are presented in abridged form but transcripts of original and more complete records have been filed with the Engineering Societies Library (29, West 39th Street, New York, U.S.A.).

Introduction

Manifolds are important elements in the design of side-filling or bottom-filling locks. There is no generally accepted basis for their design, however. Discussions of a paper presented in 1940 by R. D. Gladding, M. Am. Soc. C. E., and the absence of the subject from hydraulics textbooks are noteworthy in this connection. With few exceptions model tests used in the design of most recently built locks have been limited to models of the entire lock. Consequently, there is little basis for designing the hydraulic system of locks that must meet special requirements or operate under unusual conditions. The size and importance of the new Panama Canal locks seemed to justify more fundamental treatment. The tests described herein were adopted to this end

It is not easy to predict the time required to fill or empty a lock through a manifold system. It is customary to use a differential equation based on the orifice formula with an estimated coefficient, to compute the time required to fill or empty a lock under a falling head. Owing in part to complications resulting from inertial effects and to difficulty in allowing for time consumed by valve operations, but principally to lack of a satisfactory theory of manifold hydraulics, these attempts at simplification often have been unsuccessful.

Inequality in port discharges tends to defeat the purpose of a lock manifold. These differences in discharge are produced by changes in pressure and velocity along the manifold tube. Elimination of the differences, or compensation for the differences, is possible by various methods, discussion of which is beyond the scope of this paper. It is evident that the use of such expedients as tapered culverts, varied port sizes, and varied port spacing is highly speculative without a specific model test of each design or some knowledge of what takes place within a manifold.

Purpose.

The purpose of the tests was to provide data that would expedite the design of lock manifolds. Specifically, it was desired to give mathematical expression to the phenomenon of manifold flow in order to facilitate the original design and the modification of model manifolds. Since a single port can be built and tested quite easily and quickly, determination of a means of predicting the performance of a manifold on the basis of single port tests and verification of the technique by tests of a manifold were the principal phases of the programme.

Outline

The first part of the study, "Theoretical Considerations," describes the mathematical approach adopted for the analysis. It is perhaps regrettable that several simplifying assumptions were necessary in order to obtain tangible results without unduly extending the test programme. Substantial correctness for design purposes rather than precision was the reason for simplifying the theory to the greatest possible extent. Since disturbances within a lock chamber during emptying operations are usually (perhaps always) negligible in comparison with those that occur during filling, more attention was given to the discharge ports. The difference between filling and emptying conditions is due to the lower head-to-depth ratio which prevails during emptying operations and to the absence of what might be called jet action. The basic discussions deal with what will be called "discharge manifolds," "intake manifolds" being covered by brief supplementary statements.

The second part of the study, "Single Port Tests," covers the results of tests of seven different ports, each attached to a 6-in. square conduit. The ports were tested as both "discharge ports" and as "intake ports."

The third and final part of the study, "Verification Tests," describes tests of a manifold containing five identical ports which were duplicates of one of those tested as a single port. A 6-in. square conduit again served as the manifold tube. Observations are compared with calculations based on single port characteristics which had been determined previously.

Notation

The following letter symbols, adopted for use in this paper, conform essentially to American Standard Letter Symbols for Hydraulics, prepared by a Committee of the American Standards Association, with Society participation, and approved by the Association in 1942:

A = area:
- A_c = cross-sectional area of conduit, in square feet;
- A_p = throat area of the port, in square feet;

C = discharge coefficient in orifice formula with subscript d or i denoting discharge ports or inlet ports, respectively;

g = gravitational acceleration, in feet per second per second;

H = effective head on a given port, in feet, with subscript d or i denoting discharge ports or inlet ports, respectively;

k = a dimensionless coefficient to be studied experimentally, with subscript d or i denoting discharge ports or inlet ports, respectively;

n = Manning's roughness coefficient;

P = a ratio of discharges:
- $P_d = Q_3/Q_1$;
- $P_i = Q_3/Q_2$;

Q = discharge, in cubic feet per second:
- Q_1, in the conduit upstream from a port;
- Q_2, in the conduit downstream from a port;
- Q_3, through a port;

V = mean conduit velocity, in feet per second
- V_1, upstream from port;
- V_2, downstream from port;

Z = elevation of the hydraulic gradient in feet; Z_1 = upstream elevation and Z_2 = downstream elevation; ΔZ = difference between upstream and downstream elevations;

γ = specific weight of water, in pounds per cubic foot.

Theoretical Considerations

It is evident that any fundamental study of the hydraulics of manifolds must be based upon an analysis of the behaviour and effects of a single lateral port attached to a tube. Preliminary study made it clear that two problems were of primary importance—namely, *(a)* the pressure change which occurs in a tube in the vicinity of a lateral port and *(b)* the discharge through a lateral port and the factors that modify it. Solution of these two problems permits analysis of the hydraulics of a manifold by a simple computation procedure which resembles somewhat the calculation of a backwater curve. Mutual interference between closely-spaced consecutive ports is the principal limitation on the applicability of this procedure which otherwise appears quite general.

(a) Pressure Changes.—Consider a horizontal frictionless tube to which a discharging lateral port is attached. The port outlet is submerged in still water. The elevation of the water surface over

* Reproduced by permission from Proceedings of American Society of Civil Engineers, October, 1944.

Lock Manifold Experiments—continued

the port outlet is called the "' submergence level." The tube is connected to a source of supply which is at some elevation greater than the submergence level. Downstream from the port, the tube is throttled in such a manner that the hydraulic gradient past the port is above the submergence level. The port is of such a length that the discharge through it occurs substantially at right angles to the axis of the manifold tube. Since the tube is frictionless, the pressure gradients both upstream and downstream from the port are horizontal but at different elevations. In the immediate vicinity of the port, there is an abrupt pressure rise in the direction of flow.

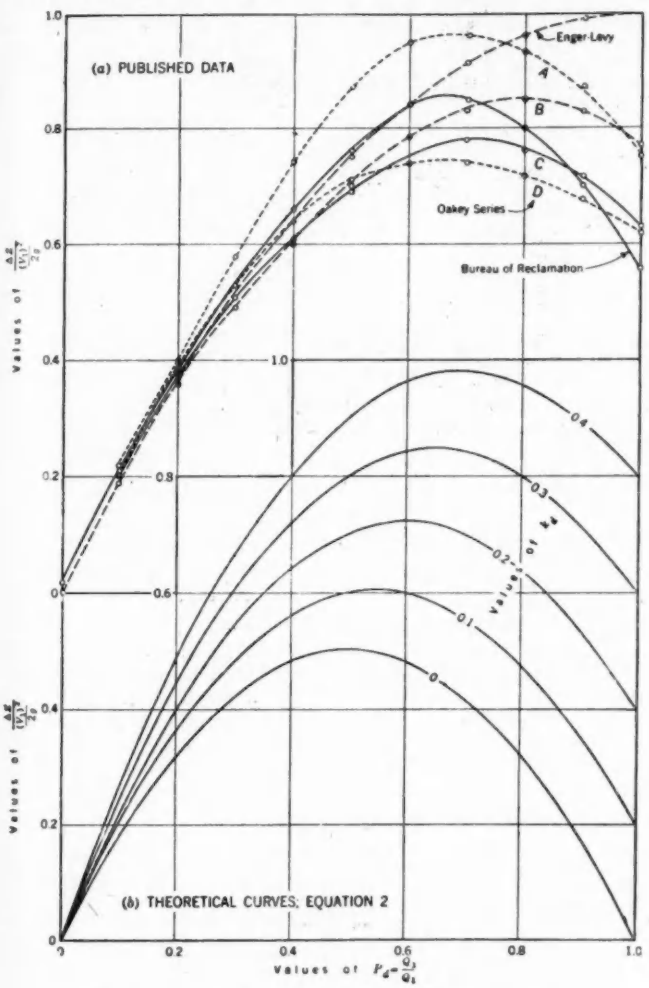


FIG. 1.—PRESSURE RISE: THEORETICAL EQUATIONS AND OBSERVED DATA

Consider the rate of change of momentum that occurs between two sections on the horizontal pressure gradients upstream and downstream, respectively, from the port. Neglecting non-uniform velocity distribution, the rate of change of momentum has the value $\frac{Q_2}{g}\gamma\,(V_1 - V_2) + \frac{Q_3}{g}\gamma\,V_1$. The forces producing this effect are the pressure rise in the conduit and the resultant of unbalanced pressures within the port. The latter force is unknown and undeterminable in any practical manner except as a residual. The unbalanced port pressure is intimately related to the momentum change of Q_3 and, therefore, it seems likely that any allowance for its effect can be applied to the term representing that momentum change.

It is considered that k_d is that fraction of the momentum change of Q_3 which is produced by a pressure rise in the conduit. Conversely, $(1 - k_d)$ is that fraction of the momentum change of Q_3 which is produced by unbalanced pressure within the port. This line of reasoning leads to an expression involving the pressure rise, an equation which is not obtainable without some simplifying assumption similar to the one which has been explained. The equation obtained is:

$$\gamma\,A_c\,(Z_2 - Z_1) = \frac{Q_2}{g}\gamma\,(V_1 - V_2) + \frac{k_d\,(Q_3\,\gamma\,V_1)}{g} \quad \ldots\ldots\ldots (1)$$

By use of the law of continuity and some algebraic manipulation, Eq. 1 may be reduced to the form,

$$\frac{\Delta Z}{(V_1)^2/2\,g} = 2\,P_d\,(1 + k_d) - 2\,(P_d)^2 \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Certain published data indicate that, for a given port and conduit, the ratio on the left side of Eq. 2 is a function of P_d only. For this to be true, k_d must be either a constant or a function of P_d only. Fig. 1 *(a)* is a comparison of tests by the U.S. Bureau of Reclamation[1] as interpreted by R. W. Powell,[2] M. Am. Soc. C. E., tests by John A. Oakey,[3] Assoc. M. Am. Soc. C. E., and the conclusions, supported by tests, of M. L. Enger, M. Am. Soc.

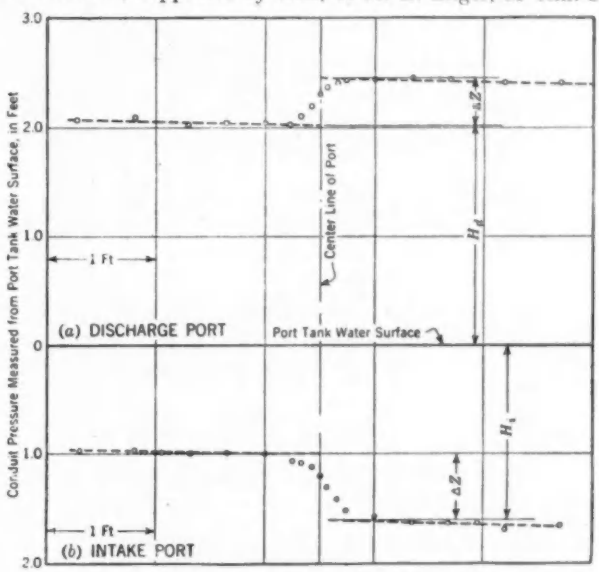

Conduit Pressure Measured from Port Tank Water Surface, in Feet
Center Line of Port
1 Ft
(a) DISCHARGE PORT
Port Tank Water Surface
(b) INTAKE PORT

FIG. 2.—TYPICAL GRADIENTS: SINGLE PORT TESTS

C. E., and M. I. Levy.[4] The approximate diameter ratios, lateral to conduit, for the tests in Fig. 1 *(a)* are as follows:

Series (see Fig. 1)	Diameter ratios
A	1:4.24
B	1:2.82
C	1:1.82
D	1:1.21
Enger and Levy	1:5.3
Bureau of Reclamation ...	1:2.3

In Fig. 1 *(b)* are plotted graphs of Eq. 2 with various constant values assigned to k_d. It is evident that this comparison tends to support the analysis.

The published data exhibit a maximum relative pressure rise in the vicinity of P_d equal to 0.7, corresponding in that respect to the theoretical curve for k_d equal to 0.4. However, the relative pressure rises are of lower magnitude than those indicated by the theoretical curve for k_d equal to 0.4.

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1 "Model Studies of Penstocks and Outlet Works," Bulletin 2, Pt. VI, Boulder Canyon Project Final Repts., Bureau of Reclamation, U. S. Dept. of the Interior, 1938.

2 "Hydraulics of Sprinkling Systems of Irrigation," by J. E. Christiansen, "Transactions," Am. Soc. C. E., Vol. 107 (1942), p. 221.

3 "Hydraulic Losses in Short Tubes Determined by Experiments," by John A. Oakey, "Engineering News-Record," June 1, 1933, p. 717.

4 "Pressures in Manifold Pipes," by M. L. Enger and M. I. Levy, Proceedings, A.W.W.A., May, 1929, p. 659.

Lock Manifold Experiments—continued

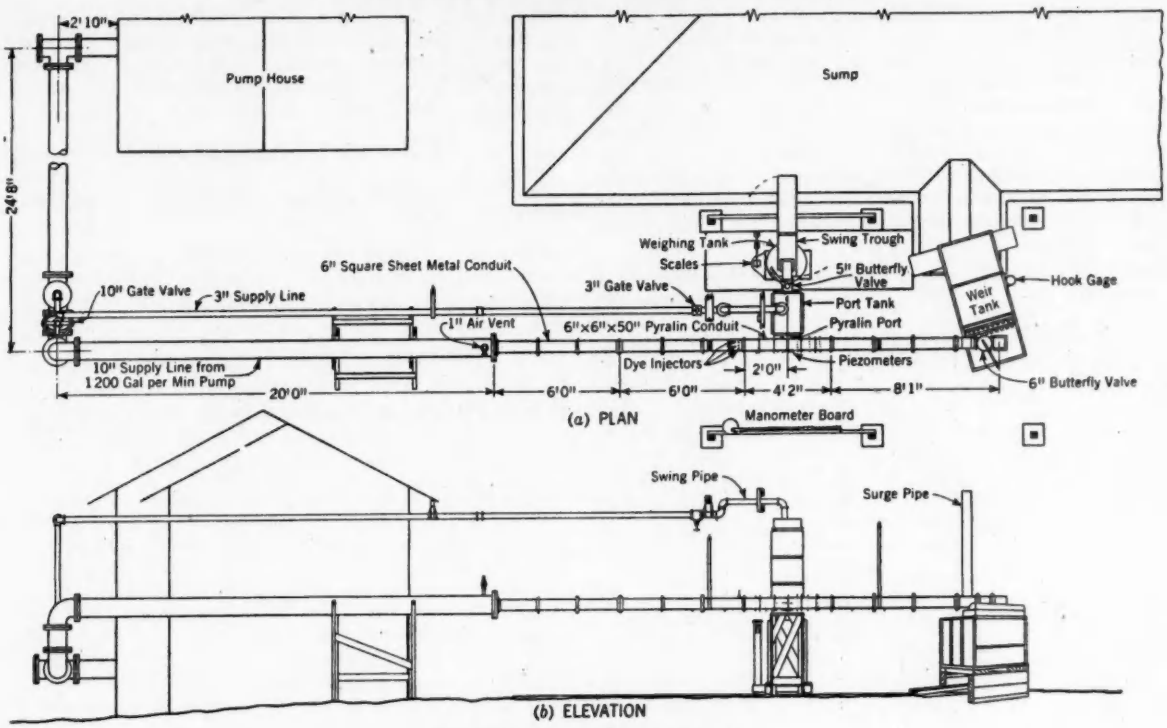


FIG. 3.—SINGLE PORT TEST APPARATUS

It should be noted that the graphs of relative pressure rise plotted against P_d are simply a convenient means of evaluating the effect of a residual unknown—the resultant of unbalanced port pressures. The graphical method could have been evolved by some other line of reasoning. However, the method appears to represent an approximately correct interpretation of the mechanics of pressure changes in manifolds. Of course, the effects of non-uniform approach velocity distribution and of angularity of port discharge are reflected in the relations between the relative pressure rise and P_d.

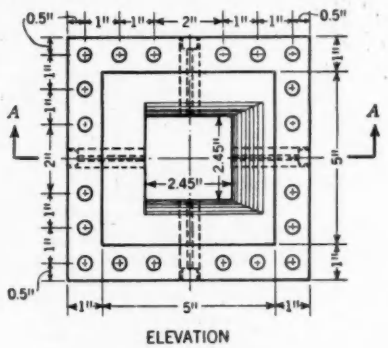
Since no real conduit is frictionless, a method had to be devised for measuring the pressure rise for a real manifold so as to minimise the effect of friction. The gradients in a real manifold are not level but, beyond the immediate effects of the port, they are straight lines. In analysis and application of pressure rise data, it is considered that the pressure change is sudden and occurs opposite the port centre line. In practice then, the upstream gradient is extended downstream and the downstream gradient is extended upstream, both at their respective friction slopes, until they intersect a vertical erected at the centre of the port. The intercept on this vertical, between the extended gradients, is considered to represent the pressure rise. As a matter of fact, the pressure rise is exceedingly abrupt. The described method of interpreting the pressure rise makes the calculated gradient for a manifold consist of a series of sloping lines with a step at each port. Fig. 2 illustrates these relations, the discharges, in cubic feet per second, being as follows:

Flow			Discharge Port	Intake Port
Q_1	...	...	2.631	1.844
Q_2	...	...	2.222	2.245
Q_3	...	...	0.409	0.401

An intake port is analyzed similarly. For an intake port, the elevation of the water surface over the port inlet is called the "submergence level." The conduit pressure gradient is below, instead of above, the submergence level. The port discharges into the conduit rather than out of it. A drop in pressure, in place of a rise, occurs in the direction of flow. The result of reasoning identical to that used for a discharge port is a similar equation,

$$\frac{\Delta Z}{(V_2)^2/2g} = 2P_s(1 + k_s) - 2(P_s)^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

It is evident from physical considerations that k_s will be larger than k_d. Since water enters the port from a quiescent pool, the unbalanced port pressure is much smaller in an intake port. Accordingly, the pressure change in the conduit (in this case a drop) must account for substantially all the momentum change.



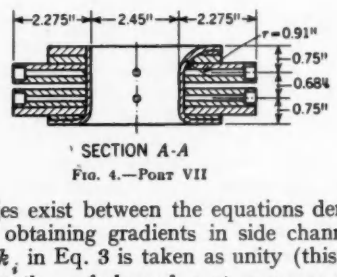


FIG. 4.—PORT VII

Certain similarities exist between the equations derived and the formulas used for obtaining gradients in side channel spillways. If k_d in Eq. 2 or k_s in Eq. 3 is taken as unity (this is equivalent to considering that the unbalanced port pressure is zero), the value of pressure change obtained — actual, not relative — will equal twice the difference between the velocity heads upstream

Lock Manifold Experiments—continued

and downstream from the port. It is evident, of course, that Bernoulli's theorem is not applicable to the phenomenon under consideration, although a modified energy equation might be used.

(b) Port Discharge.—Aftert considering various methods, it was decided to attempt to relate the port discharge to some head measurement by the use of the simple orifice equation ($Q_s = C A_p \sqrt{2 g H}$), and then to study variations in the resulting "discharge coefficient." Although it could not have been predicted definitely that this approach would be successful, study of published data indicated that it was promising.

The hydraulic gradient in the vicinity of a port changes so rapidly that there is no natural method of defining the "head on the port." Since the choice is arbitrary, the head is defined in a manner which seems definite, convenient, and logical. The elevation difference between the submergence level and the intersection of the upstream gradient with a vertical line erected opposite the centre of the port (the same intersection previously used in evaluating pressure change) is defined as the effective head, H_d, on a discharge port. This relationship is illustrated in Fig. 2.

For an intake port, the effective head, H_i, is defined as the elevation difference between the submergence level and the intersection of the downstream gradient with the intersection of a vertical line erected opposite the centre of the port. This relationship is also shown in Fig. 2.

It might appear desirable to add the head corresponding to the mean velocity of approach to the effective head for a discharge port and to make a corresponding adjustment to the effective head for an intake port. This was not done for several reasons. The method of measuring the effective head and the discharge equations are rather arbitrary so it seemed desirable to use simple definitions. The principal effect of high conduit velocity approaching the port, considering now a discharge port, would appear to be such as to reduce the port discharge. Accordingly, it seemed illogical to insert a velocity term into the discharge equation in a manner that would indicate the contrary. The effect of conduit velocity is considered separately in studying the variation in discharge coefficients. Certain minor complications which are due to the manner in which the effective head is defined are discussed in another section of the paper.

Single Port Tests

Apparatus.—The arrangement of test apparatus is shown in Fig. 3. The equipment was designed to simulate the range of heads, velocities, and port and culvert areas which ordinarily occur in lock manifolds. Port VII, shown in Fig. 4, was placed in the conduit with square corner vertical and the large radius opposite the square corner on the upstream side of the port for the discharge tests. The large radius was on the downstream side of the port for the intake tests. All verification tests were made with Port VII. Radii that are not shown in Fig. 4 are 0.36 in.

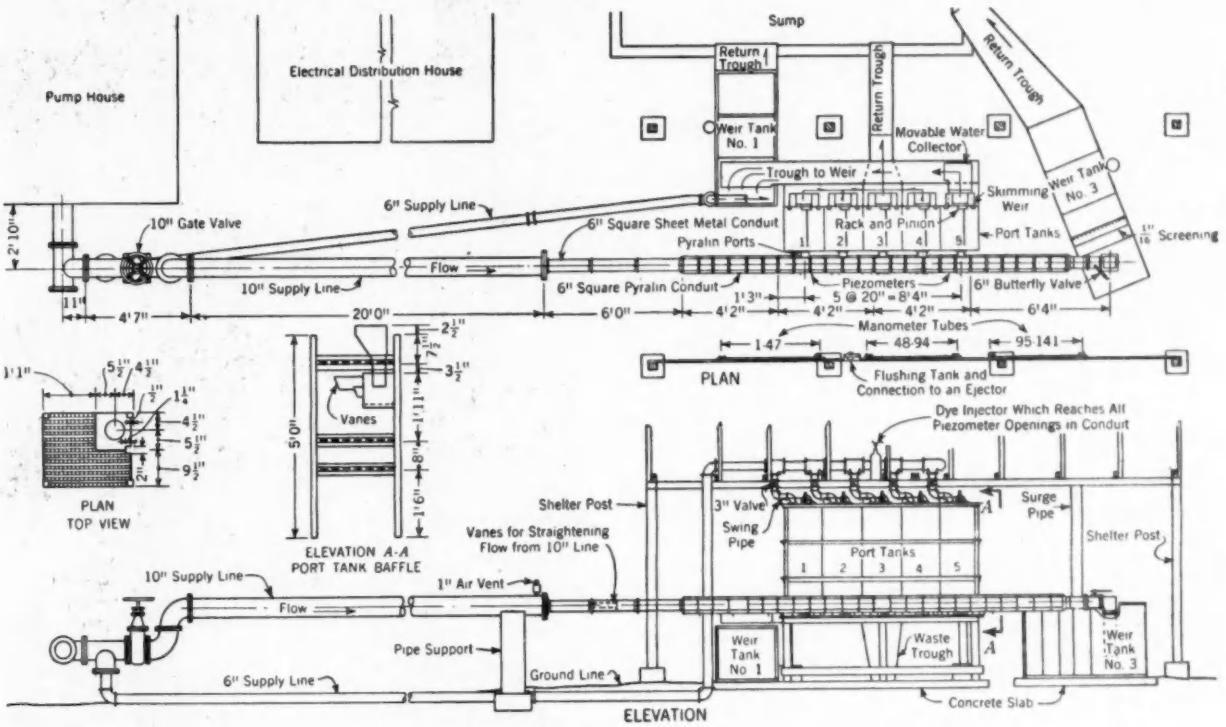


FIG. 5.—MANIFOLD TEST APPARATUS

Ports I to VI, inclusive (not illustrated), had the dimensions shown in Table 1. The ports were equipped with flanges that fitted into openings in the conduit and port tank, so arranged that the radii of the rounded ports were tangential to the tank and conduit faces; also, the faces of the sharp-cornered ports were in the planes of the tank and conduit faces.

TABLE 1.—Dimensions of Ports I to VI

Port	Length (in.)	Height and width at throat (in.)	Top and bottom at ends of port	Sides at ends of port
I	3.50	3.50	Square	Square
II	3.50	2.75	Square	Square
III	3.50	2.00	Square	Square
IV	3.50	3.50	0.75*	1.25*
V	3.50	2.75	0.59*	0.98*
VI	3.50	2.00	0.43*	0.71*

* Radius of edge fillet, in inches

In order to obtain parallel flow upstream from the port, a set of vanes was placed in the conduit as shown in Fig. 3. To simulate a discharge port, all the flow was supplied by the 10-in line. To simulate an intake port, the port discharge was supplied by the 3-in. auxiliary line. Discharges and pressures were controlled by the valve on the 10 in. pipe, the valve on the 3-in. swing pipe, the butterfly valve on the port tank outlet, and the butterfly valve at the end of the conduit.

Lock Manifold Experiments—continued

Particular care was taken in the construction of the pyralin conduit to prevent bulging under pressure. All piezometers, except those in the port tank, were placed in the pyralin sections where greater case in installation and maintenance was possible.

Flow pattern were observed by injecting dye through the piezometer connections. For some of the tests, velocities at various cross sections were obtained with a pitot tube, inserted through special openings provided for that purpose.

The level in the port tank was determined from the piezometers connected to the bottom of the tank at several points. The baffle shown in Fig. 5 was placed in the port tank to prevent excessive turbulance and entrainment of air during the intake tests. Port discharge measurements were made by diverting the flow into a 50-gal. weighing tank. Conduit discharges were measured with a calibrated 90° V-notch weir.

(*To be continued*)

Book Reviews

The Liverpool Observatory and Tidal Institute Centenary Report, issued with Annual Reports for the years 1940-45, contains a most informative and interesting account of the origin and development of the joint organisations.

The year 1945 is the actual centenary of the foundation of the Observatory, although the minutes of the Liverpool Town Council afford evidence that the project of an Observatory was before the Council as far back as 1834, with further discussions in succeeding years, until finally a scheme was approved and a building erected in 1845 on a site at the Waterloo Dock Pierhead. The Liverpool Dock Act of 1841 enabled the cost to be met out of dock dues.

The primary task assigned to the first Director of the Observatory, Mr. John Hartnup, was to ascertain " with all practical accuracy " the longitude of the Port of Liverpool and then " to obtain and preserve Greenwich Time for the benefit of the port by rating and testing chronometers and by giving the necessary information to mariners, chronometer makers and others.

Another function of the Observatory was to provide an accurate time signal, which it did every day at precisely one o'clock, p.m. by the fall of a Signal Ball similar to that in use at Greenwich Observatory. This was later supplemented by the discharge of a gun discharged electrically.

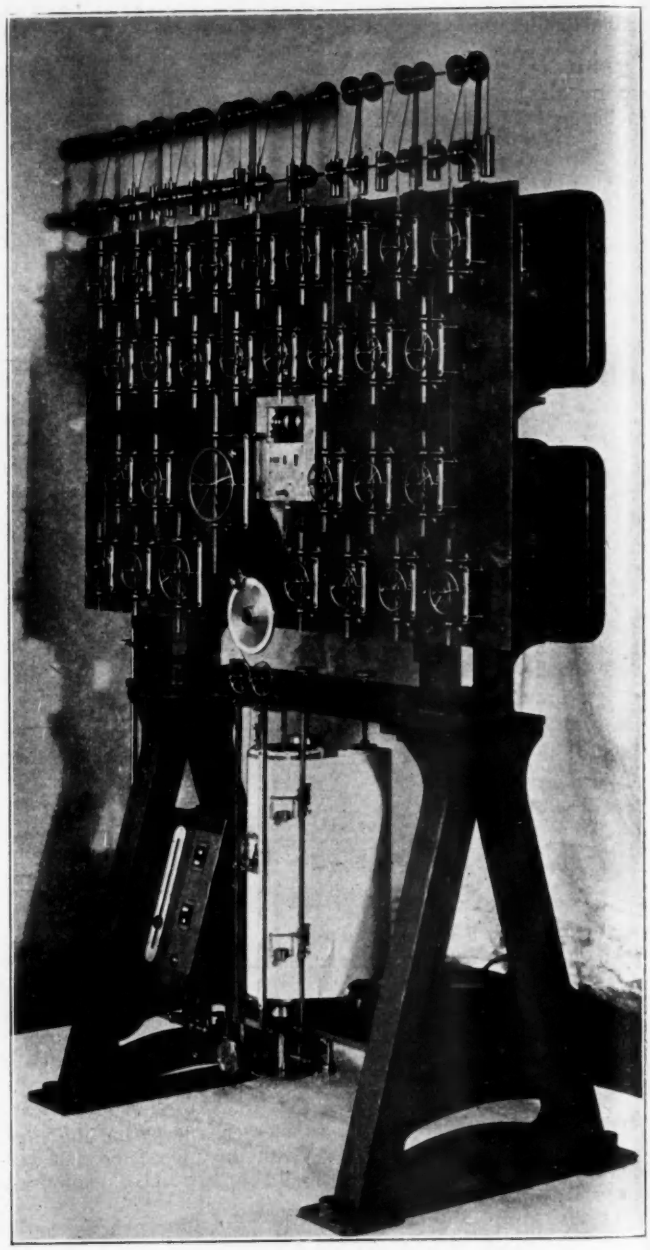
Meteorological observations were also made in a systematic manner, and an Osler self-registering anemometer and pluviometer were installed.

In 1857, there took place a change in ownership and administration. In accordance with Parliamentary legislation the Mersey Docks and Harbour Board came into existence and took over the management and control of the Liverpool and Birkenhead Docks, and with them, of the Observatory. This was followed in 1864 by a more striking physical change. The Observatory buildings at Waterloo Dock had to be demolished in connection with the construction of works at the Princes Basin. The Observatory was, accordingly, moved across the Mersey to Bidston Hill, about 3 miles from the river.

Bidston Hill had previously been used in the service of the port in a somewhat picturesque manner. It commands extensive views over Liverpool Bay, so that shipowners had found it convenient to erect on the Hill a large number of flagstaffs which were visible from Liverpool. " Each merchant of importance had his own signal, and the moment the look-out man at Bidston could identify a ship approaching the river, he would run up the flag of the trader concerned. In this way, the news of an incoming vessel preceded its arrival by several hours." The advent of the electric telegraph eventually did away with this signalling service.

The Observatory building at Bidston was constructed in a creditable manner and no expense was spared in providing an installation with equipment worthy of its object. About an acre of land was devoted to it and the building, built of stone excavated on the site, covers an area of about 500 square yards. Below ground level, there are cellars 12-ft. deep, and, below these, a cellar 24-ft. deep and 9-ft. wide through the centre of the building. At this depth, there is a very steady temperature which is a valuable asset. The cellars were utilised in connection with seismological experiments.

With the lapse of time and the introduction of photographic methods, which could only be met by excessive expenditure on modern apparatus, astronomical work at the Observatory fell into the background and though the instruments are there and still



Doodson-Légé Tide-predicting Machine

intact, they are now rarely used. The discovery of wireless telegraphy also had an important effect. Seismological research is still pursued as it is of particular utility in regard to the tilling of the land under the tidal load.

Work of the Tidal Institute

Hence the importance of the Observatory has shifted in the direction of the Tidal Institute, which had been founded in 1919

Book Reviews—continued

and was combined with the work of the Observatory as from January 1st, 1929. The Institute is under the control of the University of Liverpool, with Professor J. Proudman as Director, and Dr. A. T. Doodson as Associate Director. The objects of research include the following:—

1. A critical study of the methods of recording, analysing and predicting tides, heights and currents.
2. Further recording, analysing and predicting of heights and currents at stations for which results are desired.
3. An attempt to evaluate the constituents of long period.
4. The investigation of records with a view to discovering possible free oscillations in seas and oceans.
5. A study of the meteorological effects on tides.
6. A study of the dynamical features of tidal currents.
7. A study of the geographical distribution of the results of analysis, with a view to obtaining an improved dynamical conception of the main tidal movements.
8. A critical study of the dynamical hypothesis in vogue relating to the main tidal movements.
9. The development of the solution of the dynamical equations of the tides.

Aerial View of Bidston Observatory and Grounds

The manifold activities of the Institute are best appreciated by the statement of the tidal predictions carried out for ports throughout the world, for the inclusion of which there is no space available here and this brief notice of its work must be closed with a cordial acknowledgment of the valuable services which it has rendered and is continuing to render to port authorities, master mariners and pilots alike.

The Transport Situation in Europe, compiled by the European Central Inland Transport Organisation, No. 1, October, 1945. Pp. 29, with diagrams and 7 statistical appendices.

This is a report on the state of transport and the available facilities therefore in the Western Countries of Europe; the transport situation in Eastern Europe will be dealt with in the next Report. The present compilation provides a short survey of each form of transport in Belgium, France and the Netherlands: Railways, Roads, Waterways and Ports.

Omitting Roads and Railways as foreign to the scope of this Journal, the sections on Waterways and Ports are somewhat subordinate to the other sections and do not comprise quite so much detailed information; that which is given relates chiefly to to the restoration of routes and facilities and indicates the progress which has been made in the respective countries since occupation by the Allied Forces. There is a special section on International Waterways, dealing fairly fully with the Rhine, but very cursorily with the Elbe. As progress continues to be made in all directions, any extracts from the Report would be out of date by the time they could appear in this Journal. Copies of the publication, price 5 shillings net, can be obtained at Berkeley Square House, Berkeley Square, London, W.1.

River Tees Conservancy

Important Scheme of Riverside Development

The River Tees Conservancy Board have deposited in Parliament, for consideration during the coming session, a Bill making provision for extensive changes in their constitution and powers to enable the execution of an important scheme of development to be put in hand at the Port of Middlesbrough and in the River Tees generally.

The preamble to the Bill states that it is desirable, in the interests of the expansion of trade and shipping and in the furtherance of the co-ordinated development of the ports of the Tees, that there should be one dock and harbour authority for the river, and that the port facilities be expanded and that the excavating Middlesbrough Dock of the London & North-Eastern Railway Company be transferred to the Conservancy Commissioners and that further powers be conferred upon the latter with respect to the making and management of docks and wharves and conveniences in connection therewith.

It is proposed that the present constitution of the Board should be modified so as to give direct representation to the municipalities of Thornaby and Redcar and the Urban District Councils of Eston and Billingham and also to the Tees Wharfowners' Association and the Middlesbrough and District Association of Chartered Shipbrokers, none of whom has hitherto had any direct voice in determining the policy of the port authority.

Among the constructive proposals are (1) The purchase by negotiation of the Middlesbrough L.N.E.R. dock and its re-equipment. (2) The building of new deep water quays near the dock entrance. (3) The construction of a new deep water dock of about 38 acres area (with room for extensions) on a site near the mouth of the river in close proximity to the land recently acquired by Dorman, Long & Co. as a site for their new steel works and the larger site acquired by Imperial Chemical Industries, Ltd., for a new factory. (4) The provision of better oil and coal bunkering facilities; and (5) the deepening, diversion and improvement of the river channel.

Powers are also sought to enable the Commission to trade as wharf and dock owners, to load and discharge vessels, to perform all necessary services for shipping, and generally to act as the supreme authority over the whole of the river.

Oil Fuel Storage Tanks and Pipe Lines

Design of Modern Port Installations

By STANLEY C. BAILEY, Assoc.M.Inst.C.E., F.G.S.

(Concluded from page 190)

Effect of Oil Fuel on Concrete

WITH regard to the effect of oil fuel on cement concrete, experiments have shown that animal and vegetable oils will convert it into a saponaceous or soapy substance, and destroy it, while mineral oils have no such destructive effect, even if the oil penetrates it slightly. Neat cement briquettes immersed in oil fuel in a closed vessel for 252 days, and subjected to pressures of 660 to 860 lbs. per sq. in., were penetrated by the oil, which had no deteriorating effects on the cement. Briquettes of 1 part of cement, and 1 to 2 of sand are impervious to water pressure at 200 lbs. per sq. in. and mortars of 1 to 2½, and 1 to 3, are impervious at 100 lbs. sq. in., while a mixture of 1 to 4, is not watertight at 25 lbs. per sq. in. Several methods have been used to render the surface of weak concrete oil and watertight. One is to spray the surface with a layer from 2-in. to 3-in. thick of 1 to 2 or 1 to 3 cement and sand mortar, by means of a cement gun using 100 cub. ft. per minute at a pressure of 40 lbs. per sq. in.; another is to cover the concrete with a coat of 1-in. thick of 1 to 2 cement mortar to which from 15 to 20 lbs. of iron filings per 100 lbs. of the mortar have been added. Concrete floors and walls of kerosene tanks have been made impervious by coating the inside with thin glue, and before it sets hard, it is painted with a 5 per cent. solution of potassium bichromate. There are also a number of chemicals that have been added to concrete to render it oiltight, they include powdered alum, silicate of soda, zinc sulphate and alum, and caustic potash mixed with powdered alum; but to wash or coat the surface with neat cement is useless.

Lay Out of Tanks and Pipe Lines

The tanks are laid out in groups about 50-ft. apart from each tank, and in some installations where ground area is available, groups of 4 or 6 tanks are surrounded by an earth bank or concrete wall about 7-ft. 6-in. high and 3-ft. wide at the top, having 1½ to 1 slopes. The inner slope is made impervious by a 3-in. thick layer of 1-1½-3 cement concrete reinforced with expanded metal or wire mesh. The enclosed space less the area occupied by the tanks being sufficient to hold the contents of at least one tank, in case of accidents. Steps should be provided over the bank, and ladders on concrete walls.

Fig. 11, is a plan of typical lay-out of tanks and connecting pipes, and Fig. 12 a type of horizontal oil filter with bye-pass pipe, which is erected over a pit, the oil being pumped through it if necessary, before it is delivered to ships. The filter consists of a cast iron casing about 5-ft. 6-in. long, 2-ft. 1-in. diameter, outside and 1½-in. thick, with a hinged flanged door at the outer end, bolted to the casing, and joined to the oil main at the opposite end. Inside the casing a double-skinned mild steel cylinder slides on side runners, it has a bolted steel cover at the outer end, and is open to the inlet pipe of the oil main at the other, fitting close against the casing. The oil strainer which this cylinder forms consists of two steel shells each 5/16-in. thick, the outer one being about 16-in. in diameter outside. Between the two shells there is a layer of steel gauze coated with zinc, and both shells are perforated over the whole circumferences with 1-in. diameter holes, spaced, ½-in. apart, and opposite one another in the two cylinders. The shells are slid out periodically for scraping and cleaning. In Fig. 13 a sketch plan and elevation is shown of a vertical form of filter, this will need a tripod over it with a differential pulley block to lift the cylinder strainer.

Oil Fuel Jetties

Where wharves and jetties are used for the transfer of oil from " tankers " to the shore tanks, or for the delivery of it to ships, there should be sufficient depth of water at L.W.S.T. to enable this to be done; some " tankers " are of large size, such as 512-ft. by 63-ft. 4-in. by 34-ft. 6-in. deep, drawing 29-ft. of water when loaded with 11,000 tons of oil; and 436-ft. by 55-ft. by 32-ft. 9-in. deep, with 25-ft. 6-in. draught when loaded with 8,925 tons. As the beam of oil tankers is about ⅛ of the length, and the depth is 1/13 to 1/14 of the length, the amount of oil carried is about 20 to 21 tons per lin. ft. of the vessel's length.

In some ports where the depth of water alongside wharves at L.W.S.T. is not sufficient to allow oil ships to be berthed; special jetties are built, projecting into the harbour or rivers, for oil supply and delivery purposes, so that ships may use them at all states of the tide. The jetties and dolphins may be constructed of timber with piles 12-in. to 14-in. square, with timber cross beams, joists and decking, also cross and longitudinal bracing down to L.W.S.T. level and below if possible, or they may be formed of reinforced concrete piles and superstructure, which is the most suitable for *teredo* infested waters. Some are constructed of 6-in. diameter solid steel piles, or 12-in. diameter hollow steel screw piles, with steel joists and channel steel bracings, the decking being of timber. The live load allowed need not exceed 112 lbs. per sq. ft. Timber fenders or fender piles, bollards, ring bolts, ladders, handrails, and electric light standards will require to be provided, and probably also an office and store for flexible hose pipes, spare fittings and tools.

Figs. 14, 15, 16 and 17 illustrate types of jetties suitable for the purpose, and are self-explanatory, they are designed for deck weights and live loads totalling 170 lbs. per sq. ft.

The jetty shown in Fig. 14 is designed for rapid construction, the main members being fixed by 2-in. diameter bolts passing through the concrete piles, this necessitates all the piles being of equal length, for the same depth of water, as the holes are left in them when they are cast. The deck beams are attached by clips to the cross-beams.

In the reinforced concrete jetty (Fig. 16) the total load on each 70-ft. pile, including the weight of the pile 20-ft. in the ground will be about 30 tons.

The faces of the jetties alongside which the ships are moored should be battered 1 in 8 to 1 in 12, so that a space is provided between the ship and the jetty for the bend in the flexible hose pipe, allowed for the rise and fall of the tide.

The oil mains are usually placed on the deck of the jetty, and there may be so many as 4 or 6 lines of such mains; if there are only one or two lines, they may be slung underneath, and in some cases, water mains, petrol pipes, and electric cables, may also be necessary.

Fig. 18 shows the plan of a T-headed jetty with two dolphins for mooring vessels, this is a suitable type in the cases of rivers with strong currents, and the required depth of water only in the main channel, the head and dolphins should be of strong construction, but the arm to the shore may be much lighter. Fig. 19 illustrates the head of a straight jetty suitable for a number of ships to moor alongside either for discharging or loading purposes.

Pumping Oil Fuel

With regard to the pumping of oil fuel, ships pumps usually work at pressures of 80 to 100 lbs. per sq. in., and those of shore pumping stations at 100 to 175 lbs., but may be so much as 250 lbs. per sq. in. The pumps are of various types, and are driven by either steam, electric, or Diesel engine, but chiefly by the latter. Relief valves and air vessels should be fitted to the pumps, which are in duplicate in many cases. If relief valves are not fitted to the pumps, then a rising main about 4-in. diam. with a reflux should be fixed to the oil main near one of the tanks, carried up to a height of about 10-ft. above the top kerb of the

Oil Fuel Storage Tanks and Pipe Lines—continued

tank, bent down, and fixed at a hole in the roof sheets. In long pipe lines at oil fields some pumps work up to 150 lbs. per sq. in.

The capacity of shore pumps ranges from 200 to 300 and up to 500 tons per hour per pump, but the higher the pressure at which the pumps work, the lower will be the quantity of oil delivered, because the speed of the pumps must be reduced by gearing. There is also a certain amount of slip in the pumps due to defects and leakage in the plunger which may amount to from 10 to 15 per cent. in hydraulic pumps; to so much as 60 per cent. in oil pumps. The duty of the pumps and the working pressures, of course, depend upon the head against them, and the temperature of the oil, but some pumps under a pressure of 70 lbs. per sq. in. can deliver 300 tons of oil per hour at 50° Fahrenheit, and 300 to to 338 tons per hour at 62° Fahrenheit, also 220 tons per hour at 100 lbs. per sq. in. pressure, 200 tons at 150 lbs., and 120 tons at 200 lbs. The oil receivers and air vessels in pumping stations are cylindrical from 4-ft. 6-in. diam. by 7-ft. to 6-ft. 6-in. diam. by 10-ft. high and are usually tested to 250 lbs. per sq. in.

Fig. 20 is a diagrammatic view of the pipe and valve arrangements in a pump house for delivering oil from the tanks to ships, and vice versa.

Oil Fuel Pipe Lines

Oil fuel pipe lines from the refineries at the oil wells to the storage tanks at or near the sea ports, may be hundreds of miles long, the oil being forced through the pipes by a number of pumping stations at suitable intervals along the pipe line, the distance between the pumping stations, and the power of the pumps, depends upon the contour of the pipe line, the viscosity of the oil, and the quantity required to be delivered per hour, which also decides the necessary diameter of the pipe, which varies from 8-in. to 15-in.

Most long-distance pipe lines are laid on the surface of the ground, but in some instances they are buried in trenches about 2-ft. deep and 1-ft. 6-in. wide.

Expansion joints or U bends will be required at intervals in the pipe line, and air valves at the summits of hills or where the oil gradient falls below the anticlines.

The most economical pipe line is that which allows a velocity of flow to 3 to 4-ft. per second when pumping, and the roughness of the pipe inside has little effect on the flow of oil in stream-line flow, as the oil flows at the centre with twice the velocity that it does at the circumference in a parallel stream; but in turbulent flow when the oil whirls and eddies in various directions the pipe roughness inside will have some effect. Oils of high viscosity move in a parallel stream, while the less viscid tend to be turbulent in their flow, especially if the velocity exceeds 3 or 4-ft. per second.

The pipes may be of cast iron or steel with spigot and socket, or flanged joints and from 9 to 12-ft. long; or of mild steel solid drawn pipes, with either spigot and socket joints and in 18 to 20-ft. lengths, or with cast steel bolted flange joints, shrunk or screwed on, or right and left-hand screwed unions may be used. Cast iron pipes should only be used for low pressures, and for high pressures the most suitable are of mild steel, with flanged or screwed union joints. Mild steel pipes, 12-in. diam. and 40-ft. long, have been used.

The joints of cast iron and mild steel spigot and socket pipes are made oil-tight by ramming in lead wool, then some spun yarn, and finally lead wool to the face of the socket. The ramming should not be too severe, or the sockets of cast iron pipes may split, and in a hot climate with exposed pipes, the expansion of the lead may also split the socket. All pipe and valve flanges should be fitted with oiled asbestos or millboard joint rings $\frac{1}{8}$-in. thick.

At the Kern River oil fields, near Bakersfield, California, there is an 8-in. diam. mild steel pipe line with screwed unions, weighing 28.2 lbs. per lin. ft. and 5/16-in. thick, which is over 30 miles long, this pipe line is rifled one turn in 10-ft. 3/32-in. deep, and was tested to 1,200 lbs. per sq. in., and to 1,000 per sq. in. when laid in a trench, the pumping pressure being 800 lbs. per sq. in. The effect of rifling the pipe increased the flow of oil 8 to 10 times over that for a plain pipe. The rifling was done by indenting the outside of the pipe with 6 radially placed rollers 4.1-in. apart, under heavy pressure, and so pressing in the metal to form ridges on the inside, in lieu of grooves as in ordinary rifling. Fig. 21 illustrates a section of the ball and socket and expansion joint used for pipe connections to tanks situated on unstable ground. Pipes and valves, etc., should be tested to at least twice the maximum working pressure. Sharp T and L connections should not be used in the laying of pipes as they produce a considerable amount of friction, in a T connection, this will amount to a length of pipe equal to the diameter D in feet x 60 and in an L elbow will be = D × 30 so that easy bends where possible should be provided.

The friction in sluice valves = D × 11; and from 10 to 15 per cent. should be added to the length of the pipe line to allow for friction in all valves, bends, and connections, including filters. In a bend the friction is least when the radius of curvature is not less than 2.5 times the diameter of the pipe, it is then equivalent to the length of the bend × 3.38. The pipe connections for the flexible hoses from "tankers," or for the delivery of oil to vessels, consist of 5-in. to 8-in. diam. branch pipes on the main, fitted with valves and gun-metal bends to which the hose pipes can be attached by screwed couplings, in some cases they are arranged in duplicate, the valves being above the deck level.

Weights and Viscosities of Oil Fuel

The Specific Gravity at 60° F. of oils used as fuel varies according to the countries from which they originate, for instances, those from Mexico range between 0.9 and 0.938; from Texas—0.894 to 0.929; from Trinidad = 0.927 to 0.949; from Borneo – 0.886 to 0.929; from Burma – 0.920 to 0.924; from Persia – 0.861 to 0.898; Scotch shale oil = 0.829 to 0.869; while that of petrol spirit is 0.68. In America the Sp. Gr. of oil is measured by Beaume's hydrometer, a gravity of 0.92 = 22° one of 0.82 = 40° 0.72 = 60° and 0.61 = 90°.

A heavy oil of 0.94 specific gravity = 58.7 lbs. per cub. ft. or 38.1 cub. ft. per ton of 2,240 lbs. and 34 cub. ft. per American ton of 2,000 lbs., while a light oil, specific gravity 0.864 = 54 lbs. per cub. ft. or 41.5 cub. ft. per English, and 37 cub. ft. per American ton.

In America it is usual to measure the capacities of tanks by the barrel contents = 5.5 cub. ft. and a barrel is equivalent to 35 English, and 42 American gallons, and weighs about 320 lbs. with oil at 58.1 lbs. per cub. ft. there being about 7 barrels per English ton.

With regard to the viscosities of oil fuel, these vary considerably according to the temperature of the air, and the oil, the specific gravity and the quality. The viscosity is usually measured on a Redwood No. 1 viscosometer in seconds, for a stream line flow, and on a Redwood No. 2 instrument for turbulent flow calculations. The values on No. 1 are 10 times higher than on No. 2. At a temperature of 60° F., Scotch shale oil has a viscosity of 53 secs. (Redwood No. 1), Texas oil, 735 secs., Trinidad, 2,914 secs., Borneo, 64 secs., and Persian, 737 secs.

The viscosity of fresh water varies between 30.7 secs. at 35° F. and 29.5 secs. at 50° F. on Redwood No. 1 viscosometer. The flash point (Abel's close test) of oil fuels varies between 145° F. and 273° F., but most average about 245° F. It should not be less than 150 to 173° F.

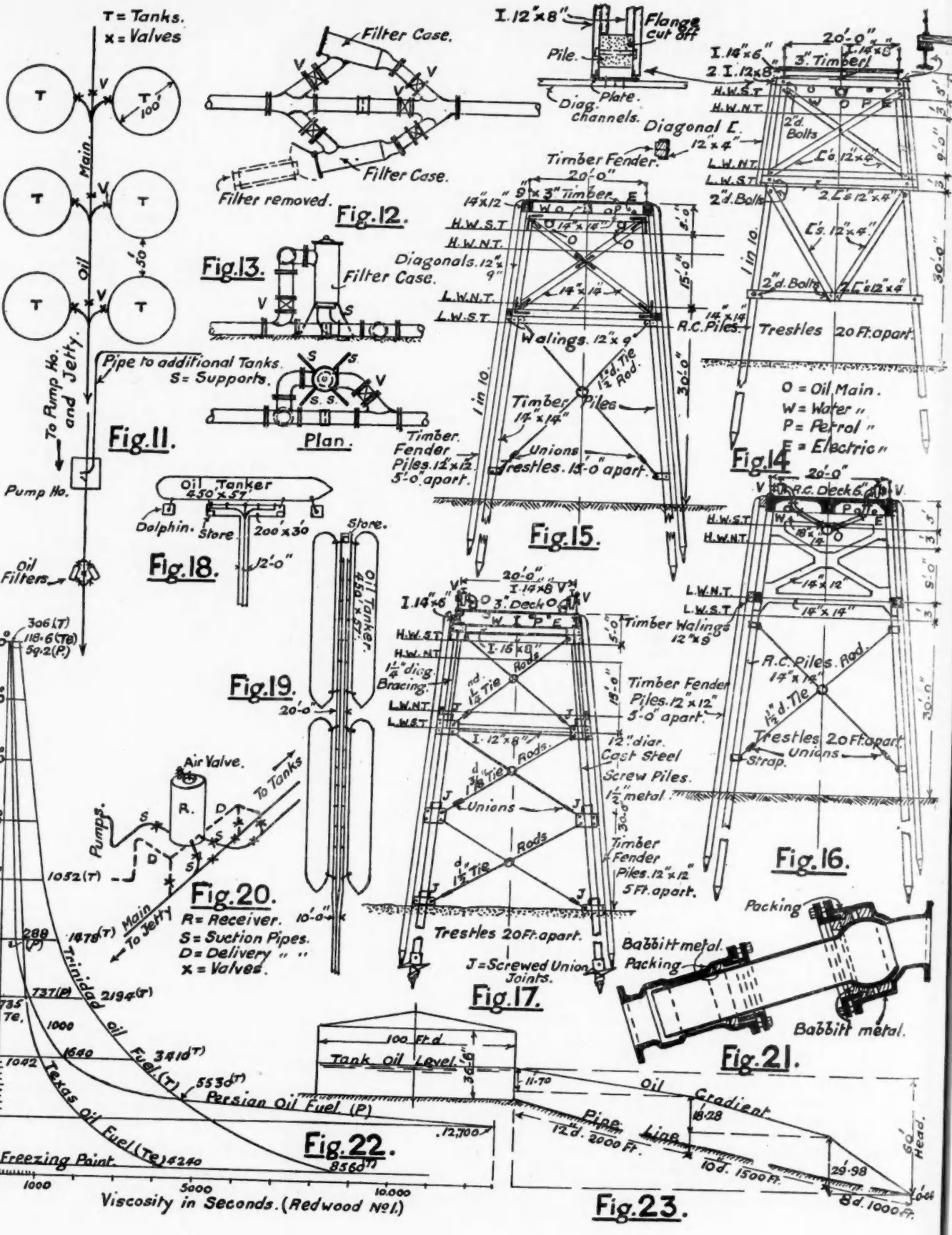
In practice for the purpose of calculating the rate of flow of oil in pipes, viscosities of about 350, up to 500, and even 1,000 secs. on Redwood No. 1 viscosometer are taken in hot climates, and 1,500 to 2,000 in cold regions.

The kinematic or motion viscosity (μ) at 32° F. on a Redwood No. 1 viscosometer is – $\mu = 0.0000028.T - \frac{0.00185}{T}$, and on a Redwood No. 2 $\mu = 0.0000291T - \frac{0.0129}{T}$ where T is the temperature of the oil in degrees Fahrenheit. The diagram Fig. 22 illustrates what a great variation there is in the viscosities of several oil fuels at different temperatures.

Calculations for Flow of Oil in Pipes

The actual delivery by gravitation of oil in pipes cannot be accurately calculated unless the temperature and viscosity of a

Oil Fuel Storage Tanks and Pipe Lines—continued



Oil Fuel Storage Tanks and Pipe Lines—continued

particular oil is known, as the variation is so great at different temperatures.

Formulæ for calculating the delivery by gravitation of oil in pipes for stream line flow, are as follows, viz.:—

$V = G \frac{H}{L} \times \frac{D^2}{\mu}$. $H = \frac{V.L.\mu}{G.D^2}$. $T = \frac{V.A. \times 3600}{C}$ and for turbulent flow,

$V^{1.72} = K \frac{H}{L} \times \frac{D^{1.32}}{\mu^{0.225}}$ $\qquad H = \frac{V^{1.72} \times L \times \mu^{0.225}}{K \times D^{1.32}}$

Where V = velocity in feet per sec., G = a constant = 0.7723 and Log G = 1.88778, L = length of pipe in feet, H = effective head in feet, K = A constant = 280.8, and Log K = 2.4484, μ = absolute kinematic viscosity of the oil at 32° F. T = tons (of 2,240 lbs.) delivered per hour. A = area of pipe in sq. ft., D = diar. of pipe in ft. and C = number of cub. ft. per ton of 2,240 lbs.

To calculate the delivery by gravitation of oil fuel pipes of varying diameters from the tanks to the wharf, with stream line flow, the following procedure may be adopted, viz.: Assuming a pipe 4,500-ft. long divided into three sections with a 12-in. diam. pipe 2,000-ft. long from the tanks; a 10-in. pipe for 1,500-ft. and an 8-in. pipe for 1,000-ft. under a total head of oil of 60-ft. to half the depth of the tank to be emptied, as shown in Fig. 23. Assume a delivery of 200 tons per hour (the figure taken is immaterial for the purpose of the calculations). The viscosity of the oil is taken at 750 seconds (Redwood No. 1), and $\mu = 0.0021$ the specific gravity of the oil is 0.896 = 56 lbs. cub. ft. or 40 cub. ft per ton. The velocities required in each pipe required to deliver 200 tons per hour will be for the 12-in. pipe $= V = \frac{T \times C}{3600 \times A} = \frac{200 \times 40}{3600 \times 0.784}$ = 2.83-ft. per sec. for the 10-in. pipe (area 0.545 sq. ft.) V = 4.07-ft. per sec. and for the 8-in. pipe (area 0.348 sq. ft.) V = 6.38-ft. per sec; where V = velocity in ft. per sec. T = tons per hour; C = cub. ft. per ton of oil, and A = area of pipe in sq. ft.

Then allowing for the viscosity of the oil, the head required to deliver 200 tons per hour in the 12-in. pipe will be $= H = \frac{V.L.\mu}{G.D^2}$

$= \frac{2.83 \times 2000 \times 0.0021}{0.7723 \times 12} = 15.3$-ft.; for the 10-in. pipe, H = 23.9-ft., and for the 8-in., H = 39.2-ft., a total of 78.4-ft.; therefore $\frac{60}{78.4} =$ 0.765. The actual required will be as follows, viz.:—

for 12-in. pipe $15.3 \times 0.765 = 11.70$-ft.
for 10-in. pipe $23.9 \times 0.765 = 18.28$-ft.
for 8-in. pipe $39.2 \times 0.765 = 29.98$-ft.

Total 59.96-ft.

The approximate delivery of each section of pipe will be the same, so taking that of the 10-in. pipe 1,500-ft. long the mean velocity will be $V = G \frac{H.D.^2}{L.\mu} = 0.7723 \frac{18.28 \times 0.833^2}{1500 \times 0.0021}$

$= 4$-ft. per sec. and the delivery in tons per hour $= T \frac{V.A.\ 3600}{C}$

$= \frac{4 \times 0.545 \times 3600}{40} = 196.2$ tons.

Retirement of Port Official.

Mr. C. May-Smith, Chief Cashier of the Mersey Docks and Harbour Board has just retired after nearly 50 years service, and the occasion was marked by the presentation to him of a handsome standard lamp by Mr. J. B. Roberts, the Docks Treasurer, in the presence of his colleagues in several departments. Mr. May-Smith has served under six treasurers of the Board.

Notable Port Personalities

LI—*Mr. W. A. Souter*

The new Chairman of the Tyne Improvement Commissioners, **Mr. William Alfred Souter,** was a member of the Blyth Harbour Commission from 1922 to 1926, in which latter year he became a member of the Tyne Improvement Commission, and of this body he has been Chairman of the Finance Committee since November, 1939.

Mr. W. A. SOUTER
(Chairman, Tyne Improvement Commission)

Among other important offices which he has held, he has been Chairman of the Chamber of Shipping Port Facilities Committee and President of the Chamber; President of the Baltic and International Maritime Conference; Chairman of the North of England Shipowners' Association; member of about 40 different committees connected with shipping, including the Merchant Shipping Advisory Committee to the Board of Trade and the Shipping Defence Advisory Committee. As Chairman of the Wireless Committee of the International Shipping Conference, he was Chief Shipping Representative at several International Wireless Conferences. He is at present a member of the General Council of British Shipping.

Mountstuart Dry Docks

At the 43rd Ordinary General Meeting of Mountstuart Dry Docks, Ltd., the Chairman (Mr. William Lion) announced that during the war period no less than 35 million tons of shipping had been handled for repairs and overhaul, and this, notwithstanding heavy air raid damage to the Company's docks and premises. Out of six establishments, only the Tredegar Dry Dock at Newport escaped. At Cardiff, a portion of the walls of two dry docks collapsed, while at Barry and Newport there was considerable damage, though of a less serious nature. However, all the docks and plant were repaired in the shortest possible time.

Mersey Docks and Harbour Board

Chairman's Annual Statement

At a meeting of the Mersey Docks and Harbour Board on December 12th, **Sir Thos. A. L. Brocklebank, Bart.,** the chairman, made his first annual statement since the outbreak of war.

He said he hoped he would be forgiven if he spoke for a moment on the achievements of the port during the war years, as they were really rather remarkable. The total general cargo, excluding oil and coal, handled during the war was over 70 million tons; on at least three occasions, over one million tons were handled in a single month, despite the black-out and the very considerable reduction in facilities as a result of air raid damage, which compares with a normal pre-war monthly tonnage of about 700,000. He thought it a record of which to be justly proud and credit would go to all the staff, the railways, road transport, and last, but by no means least, to the dock workers for a very fine performance.

Continuing, he said: The Board's accounts for the year ended July 1st last, just published, contain an interesting analysis of the financial ups and downs of the war years—down to a very low ebb about the time of the 1941 blitz, and thence steadily rising, as we took our part in the preparations for the North African Invasion, to a peak around the time of " D " Day. These latter figures look and were good, but our friends the Tax-gatherers saw to it that there was little left to us, though they did allow us to set aside a certain amount for Deferred Repairs. The figures are affected to some extent by variations in rates. On July 2nd, 1941, a surcharge of 60 per cent. came into force. This surcharge was reduced to 25 per cent. on April 2nd, 1944. The reduction was made at our request, as revenue was so buoyant that the maintenance of the 60 per cent. was unjustified and was really increasing the Board's liability for Income Tax. We fully expected, however, that the cessation of hostilities and the termination of Lend-Lease would bring about a sharp fall in imports, before the export trade could get going again. This has duly come to pass and we have felt it necessary to make application to the Ministry of War Transport for a substantial increase in the surcharge. The War Damage position has yet to be cleared up, but I am confident that a fair settlement of our very large claims will be reached in the not too distant future.

You will remember that two years ago I gave you a rough outline of our plans for the reconstruction of the damaged areas and the modernisation of the port generally. Since then we have obtained Parliamentary sanction for a substantial increase in our borrowing powers to enable us to go ahead with the schemes proposed. Like everyone else, we are at present gravely handicapped by the acute shortage of labour and materials, but we have now started to repair the bomb damage in the Gladstone-Hornby passage, and to complete the new Waterloo River Entrance, work on which had to be suspended in 1942 when the job was nearing completion. The plans for a new deep-water entrance to the Canada Dock system are at an advanced stage and we also contemplate making some major improvements to an important section of the Birkenhead Docks. These are all engineering works, and should not, therefore, seriously interfere with our concurrent programme of rebuilding the many sheds destroyed or damaged by enemy action. The General Manager has had many discussions with ship-owners and traders as to the types of sheds, cranes, etc., most suitable for the various classes of ships and cargoes to be handled, and I think we know fairly well what is required. It now remains to get the labour and materials to put these ideas into practice and I am afraid this is bound to be difficult until the present acute housing problem is solved.

Every effort is being made to attract new industries to the port area and several promising proposals are under active consideration. Meanwhile, an exhaustive survey of the present system of Master Porterage has been completed and certain recommendations are about to be made which, it is hoped, will lead to still greater efficiency in this operation.

Throughout the last six years, special attention has been given to the question of providing better amenities not only for the Board Employers but for all who work on the docks. A large number of canteens have been built, and medical centres provided at strategic points over all the dock estate.

We live under conditions which change so often and so rapidly that what the future has in store for us is anybody's guess. But this much I do know: The prosperity of Merseyside depends fundamentally on the docks and so long as it is left to this Board to administer those docks, we shall do everything in our power to make and keep them up-to-date and efficient; for only by so doing shall we attract the ships and cargoes which are so essential for the livelihood and well-being of our community.

In conclusion, I have to thank our most efficient and loyal staff for their work and to acknowledge with gratitude the care and energy which they have given to the service of the Board under very difficult conditions.

Clyde Lighthouses Trust

At the annual meeting in Glasgow recently, **Mr. George A. Workman** was re-elected Chairman and **Colonel Campbell,** Vice-Chairman.

Mr. Workman announced the installation of a system of wireless telephony which would permit of communication between the works at Port Glasgow and any of the lighthouses to and from the Trustee's vessel *Torch*. He further announced that a new lighted buoy had been laid off Princes Pier, on the south side of the river, to mark the entrance of the channel. A more powerful electric light was being installed at the Port-Glasgow Perch Light and a new lighted buoy laid in the Kyles of Bute to assist navigation in these narrow waters.

A survey of the river channel showed that the channel had maintained its depth very satisfactorily. There had been a slight silting up in the north bank over a small area, which did not affect the channel proper, and it was hoped to have the silt removed by the early spring.

Commenting on the accounts, which were the first they were allowed to publish since pre-war days, Mr. Workman said the year just closed had been quite satisfactory, but it was expected that, owing to the falling off in shipping, there would be a considerable reduction in the dues in years to come.

In the year under review the dues on vessels showed a decrease of £896. The ordinary expenditure amounted to £19,103, to which had to be added £10,800 placed to special reserves, and made up of £1,000 for gas works and workshops, £1,000 towards replacement of the *Torch*, £4,600 for dredging and maintenance of the channel, and £4,200 for income tax provision.

Against a total expenditure of £29,903, revenue came to £28,160, showing a loss on the year of £1,743. From the general reserves £10,000 had been deducted for the employees' pension fund, and it was hoped soon that the pension scheme would be completed.

SITUATIONS VACANT

Required in Drawing Office of Civil Engineer-in-Chief's Department, Admiralty, Designers for Maritime work associated with Post War Reconstruction Programme.

Candidates should preferably be Associate Members of the Institute of Civil Engineers or hold a University Degree, and should have at least 7 years design experience of dock, harbour and jetty work.

Salary: Up to £8 per week according to qualifications and experience, plus Civil Service War Bonus (at present 23s. per week). Overtime payment made for hours in excess of 44. All serving designers with a salary of £8 per week will be considered for increase up to £9 per week as vacancies in higher grade occur.

Employment will be at Northwood Hills, Middlesex, after January, 1946.

Write, quoting E. 2162A, to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application form, which must be returned completed by 25th January, 1946.